Studies on the Effect of Different Dates of Sowing Varieties and Number of Irrigations on Yield Attributes, Yield and Quality of Linseed (*Linum Usitatissimum* L.) Under Bundelkhand Conditions of U.P.

THESIS

SUBMITTED TO

BUNDELKHAND UNIVERSITY, JHANSI

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

AGRONOMY

2002

BY

MATADIN LODHI

B. N. V. COLLEGE RATH (U.P.)

Under the Supervision of :

Dr. D. V. S. CHAUHAN

Ex. Prof. and Head Agronomy

College of Agriculture, Gwalior - 474002

Dr. D.V.S. Chauhan
D.Sc.,
Ex. Professor & Head Agronomy,
College of Agriculture, Gwalior.

CERTIFICATE

This is to certify that thesis entitled "STUDIES ON THE EFFECT OF DIFFERENT DATES FO SOWING, VARIETIES AND NUMBER OF IRRIGATIONS ON YIELD ATTRIBUTES, YIELD AND QUALITY OF LINSEED (LINUM USITATISSIMUM L.) UNDER BUNDELKHAND CONDITIONS OF U.P." is an original piece of research work done by Shri Mata Din Lodhi under my supervision for the degree of Doctor of Philosophy in Agronomy of Bundelkhand University, Jhansi (U.P.).

I further certify that :

1. The thesis has been completed in the specified time.
2. It embodies the work of the candidate himself.
3. It is an original piece of research work.
4. The thesis fulfils the requirement of attendance as laid down by the University.
5. It is upto the standard, both in respect of its contents and literary presentation for being referred to the examiners.

DVSingh

(Dr. D.V.S. Chauhan)

25/3/03

ACKNOWLEDGEMENT

I deem it to be my proud to express my deep sense of gratitude of Dr. D.V.S. Chauhan, Retd. Professor and Head Department of Agronomy, College of Agriculture, Gwalior (M.P.) for the inspiration and talented guidance, keen interest, valuable suggestions and constructive criticism throughout the progress of this investigation without which the work would not have come to its final shape.

I am extremely grateful to Dr. L.N. Agrawal, Principal, Brahmanand Mahavidyalaya, Rath (Hamirpur), U.P. for providing the all facilities and care to conduct for the present experiment.

I am highly obligate to Dr. U.P. Singh Reader Agronomy, Dr. Varun Pratap Singh Lecturer Agronomy, Shri B.K. Pandey Lecturer Agronomy, Shri Vishram Ram Lecturer Agronomy, Dr. R.D. Mahan Lecturer Agri. Chemistry and all staff members, Brahmanand Mahavidyalaya, Rath (Hamirpur), U.P. for their cooperation and useful suggestions during the course of investigation and preparation of the manuscript.

I am also grateful to Dr. O.P. Mathuriya Prof. Agronomy Oilseed Section, C.S. Azad University of Agriculture and Technology, Kanpur for his valuable suggestions and encouragement during the preparation of the manuscript.

I am deeply obliged to Dr. V.B. Singh, Deptt. of Statistics, College of Agriculture, Gwalior for his statistical guidance.

I am also thankful to Shri Vivek Singh and Ashish Singh for taking pain for good typing of the manuscript in a short time.

My sincere thanks are due to Shri Rajeev Kumar Gupta, Shri Babulal Teacher, Shri Ashok Kumar Singh Rajput, Shri Yogendra Kumar Rawat, Lab. Asstt. who have helped me during the present investigation.

Lastly but not least, my heartiest thanks are due to my children Dr. A.S. Rajput, Mr. Surendra Singh, my daughter who have always kept pace with me to reach at the present stage.

Place : Rath
Dated: 26/03/2002

M D Lodhi

(Mata Din Lodhi)

CONTENTS

S.NO.	CHAPTER	PAGE NO.
1.	INTRODUCTION	1-6
2.	REVIEW OF LITERATURE	7-40
3.	MATERIAL AND METHODS	41-59
4.	EXPERIMENTAL FINDINGS	60-145
5.	DISCUSSION	146-167
6.	SUMMARY AND CONCLUSION	168-180
	BIBLIOGRAPHY	i-viii
	APPENDIX	i-xxx

LIST OF TABLES

Table No.	Title	Page No.
1&2	Meteorological data during rabi seasons of 1998-99 & 1999-2000.	42
3	Previous history of the field.	43
4	Physical characteristics (Mechanical composition of soil).	43
5	Chemical characteristics of soil.	44
6	Treatments and their symbols.	45
7	Details of treatment combination.	46
8	Details of the field operations.	48
9	Skeleton of analysis of variance for split plot experiment (a split factorial arrangement).	57
10	Effect of different treatments on the plant population per plot.	61
11a	Effect of different treatments on fresh weight of plants at 30 & 60 DAS.	63
11b	Effect of different treatments on fresh weight of plants 90 days after sowing and at harvest.	66
11c	Interaction effect of DxV on fresh weight of plant at 90 DAS.	67
11d	Interaction effect of DxV on fresh weight of plant at harvest.	68
11e	Interaction effect of VxI on fresh weight of plant at harvest. (Year-1998)	69
12a	Effect of different treatments on dry weight of plants 30 DAS and 60 days after sowing.	71
12b	Interaction effect of DxV on dry weight of plant at 30 DAS.	72

Table No.	Title	Page No.
12c	Effect of different treatments on dry weight of plant 90 days after sowing and at harvest.	75
12d	Interaction effect of DxV on dry weight of plant at harvest.	76
13a	Effect of different treatments on days to 50% flowering.	78
13b	Interaction effect of DxV on day to 50% flowering.	79
14	Effect of different treatments on days to 50% maturity.	81
15a	Effect of different treatments on height of main shoot 30 and 60 days after sowing.	84
15b	Interaction effect of DxV on height of main shoot at 30 DAS.	85
15c	Interaction effect of DxV on height of main shoot at 60 DAS.	86
15d	Effect of different treatments on height of main shoot 90 DAS and at harvest.	88
16a	Effect of different treatments on number of primary branches/ plant.	91
16b	Interaction effect of DxV on number of primary branches/plant.	92
16c	Interaction effect of DxI on number of primary branches/plant. (Year-1998)	92
17a	Effect of different treatments on number of secondary branches/ plant.	95
17b	Interaction effect of DxV on number of secondary branches/plant.	96
17c	Interaction effect of DxI on number of secondary branches/plant. (Year-1999)	97
17d	Interaction effect of VxI on number of secondary branches/plant. (Year-1999)	97
18a	Effect of different treatments on number of tertiary branches/ plant.	99
18b	Interaction effect of DxV on number of tertiary branches/plant.	100

Table No.	Title	Page No.
19a	Effect of different treatments on number and weight of capsules/plant (g).	103
19b	Interaction effect of DxV on number of capsules/plant.	104
19c	Interaction effect of DxV on weight of capsules/plant.	105
20a	Effect of different treatments on number and weight of seeds/ capsule.	107
20b	Interaction effect of DxV on number of seeds/capsule. (Year-1998)	108
20c	Interaction effect of DxV on weight of seeds/capsule. (Year-1999)	109
21a	Effect of different treatments on weight of capsule.	110
21b	Interaction effect of DxV on weight of capsule (mg).	112
21c	Interaction effect of DxI on weight of capsule (mg). (Year-1998)	113
21d	Interaction effect of VxI on weight of capsule (mg).	113
22a	Effect of different treatments on weight of seeds (g)/plant.	115
22b	Interaction effect of DxV on weight of seeds/plant.	116
23a	Effect of different treatments on total produce (Grain+Stover) q/ha.	119
23b	Interaction effect of DxV on total produce.	120
23c	Interaction effect of VxI on total produce. (Year-1998)	120
24a	Effect of different treatments on seed yield q/ha.	123
24b	Interaction effect of DxV on seed yield q/ha.	124
24c	Interaction effect of VxI on seed yield q/ha. (Year-1998)	124
25a	Effect of different treatments on stover yield.	127
25b	Interaction effect of DxV on stover yield q/ha.	128

Table No.	Title	Page No.
26	Oil content per cent in linseed influences by dates of sowing, varieties and level of irrigations.	130
27a	Effect of different treatments on oil (q/ha).	133
27b	Interaction effect of DxV on oil (q/ha).	134
27c	Interaction effect of VxI on oil (q/ha). (Year-1998)	134
28	Effect of different treatments on protein per cent in linseed.	135
29	Showing common cost of cultivation (Rs/ha).	137
30	Charges for harvesting, threshing, winnowing and packing.	138
31	Cost of cultivation, gross income, net income and B/C ratio in 1998-99 year	139
32	Cost of cultivation, gross income, net income and B/C ratio in 1999-2000 year	141
33	Net return per hectare in the year 1998 and 1999.	143
34	Equation for filling the response curve for dates of sowing and number of irrigations as influenced by linseed varieties.	144

LIST OF FIGURES

Fig. No.	Title	Page Between
1	Meteorological data during rabi season 1998-99.	42-43
2	Meteorological data during rabi season 1999-2000.	42-43
3	Layout Plan.	47-48
4	Effects of dates of sowing on fresh weight/plant.	68-69
5	Effects of varieties on fresh weight/plant.	68-69
6	Effects of irrigation levels on fresh weight/plant.	68-69
7	Effects of dates of sowing on dry weight/plant.	75-76
8	Effects of varieties on dry weight/plant.	75-76
9	Effects of irrigation levels on dry weight/plant.	75-76
10	Effects of dates of sowing, varieties and irrigation levels on days to 50% flowering.	79-80
11	Effects of dates of sowing, varieties and irrigation levels on days to 50% maturity.	81-82
12	Effects of dates of sowing on height of main shoot.	88-89
13	Effects of varieties on height of main shoot.	88-89
14	Effects of irrigation levels on height of main shoot.	88-89
15	Effects of dates of sowing, varieties and irrigation levels on number of primary branches.	92-93
16	Effects of dates of sowing, varieties and irrigation levels on number of secondary branches.	96-97

Fig. No.	Title	Page Between
17	Effects of dates of sowing, varieties and irrigation levels on number of tertiary branches.	99-100
18	Effects of dates of sowing, varieties and irrigation levels on number of capsules/plant.	104-105
19	Effects of dates of sowing, varieties and irrigation levels on weight of capsules/plant.	104-105
20	Effects of dates of sowing, varieties and irrigation levels on number of seeds/capsule.	108-109
21	Effects of dates of sowing, varieties and irrigation levels on weight of seeds/capsules	108-109
22	Effects of dates of sowing, varieties and irrigation levels on weight of capsule.	113-114
23	Effects of dates of sowing, varieties and irrigation levels on weight of seeds/plant.	115-116
24	Effects of dates of sowing, varieties and irrigation levels on total produce.	120-121
25	Effects of dates of sowing, varieties and irrigation levels on seed yield.	124-125
26	Effects of dates of sowing, varieties and irrigation levels on stover yield.	128-129
27	Effects of dates of sowing, varieties and irrigation levels on oil content.	130-131
28	Effects of dates of sowing, varieties and irrigation levels on oil yield.	134-135
29	Effects of dates of sowing, varieties and irrigation levels on protein content.	136-137

INTRODUCTION

CHAPTER-I

INTRODUCTION

Among oilseed crops, linseed is one of the important oilseed as it has significant commercial importance. Linseed (*Linum unsitatissimum* L.) is commonly known as flax and it belongs to the family Linaceae. Linseed is originated in South-Western Asia and the Mediterranean area of Europe and is normally grown towards the end of rainy season. The oilseed crops are grown in 5.5million hectares in whole of the universe and out of this, this crop was grown on 274.50 lakh hectares with an annual production of 256.80 lakh metric tonnes during 1998-99 in India (the Hindu Survey of Agriculture 2000).

The main oilseed crops in India rank in the following order- Groundnut, Rapeseed and Mustard, Soybean, Sesamum, Sunflower, Linseed, Castor, Safflower and Niger. Out of these nine crops linseed is an important rabi oilseed crop next only to rapeseed and mustard in India in terms of area as well as production. India has more than 18.76 lakh hectares under linseed with production of about 4.70 lakh metric tones. The area is 32.4% and the production is 18.7% of the world area and production (Rai 1999).

Based on agro-climatic situations the linseed crop is cultivated in following zones comprising different states of India:

1. North-Western region(Zone-I)-HimachalPradesh, Punjab, Haryana and its adjoining areas of Rajasthan.
2. North-Eastern region (Zone-II)-Uttar Pradesh (Excluding Bundelkhand), Bihar, West Bengal and Assam.

3. Central Peninsular region (Zone III)-Bundelkhand of Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharastra, Karnataka and Orissa.

Now per capita consumption of oils and fats per year in India is 4.6 kg as against world average of 7.0 kg (Tomar 1998). The availability of oils and fats in our country is only 12 g per day per head as against a minimum requirement of 18 g recommended by F.A.O. To meet this minimum requirement, the estimated edible oil demand per capita consumption has been assumed at 7.2 kg being the latest official report of consumption (Economic Survey of India 1995-96). Just to meet this minimum nutritional requirement, we shall have to produce one and half times as much oilseeds as the current production. However to meet the demand of our present population of more than one billion, we have to produce double the production.

The consumption of the vegetable oil is assumed as 67.55 lakh tonnes (edible oil 60.05 and industrial oil 7.50 lakh tonnes) against the net domestic supply estimated 58.9 lakh tonnes (oils and fats Review 1995). These figures tell us about the low productivity of oilseed crops in the country. Thus oilseed production has assumed importance in India because of the gap in demand and supply, which forced our country to import vegetable oils to the tune of more than 220 million approximately (Tomar 1998). Unfortunately the gap is continuously widening and causing a heavy drain on the foreign exchange reserve of the country.

Linseed has its manifold uses and therefore it is considered to be important oilseed which makes the economy of the country. Every part of the linseed plant is utilized commercially either directly or after processing. No doubt, linseed is a non edible oilseed crop, yet the seed originally used for extracting oil. According to Sharma (1999) linseed contains following:

Oil 37-43 per cent, protein 20.3 per cent, fat 36 per cent, carbohydrate 29.0 per cent, fibre 4.8 per cent, ash 2.4 per cent, water 6.6 per cent. Linseed oil contains 34.3-65.8 per cent linolenic acid, due to which it dries quickly. Therefore almost 80 per cent of total linseed oil goes to industries.

Out of this a major portion is used in manufacturing paints and varnishes and 11 per cent in manufacturing of linoleun and oil cloth, 3 per cent in printing, pad ink and rest in soaps, patent leather and other products. In some of the countries, linseed oil is used in the process of cementing of roads whereas its oil is used in most of the countries for the synthesis of antibiotics. In addition, linseed cake obtained after extracting oil contains oil 3 per cent, protein 12 per cent, carbohydrate 10 per cent, fibre 31.2 per cent, and water 8.0 per cent (Sharma 1999) is also very useful as animal feed for milch cattle. The cake can also be used as manure as it contains 5.7 per cent nitrogen, 1.4 per cent phosphorus and 1.8 per cent potash. Linseed plant stem yields fibre of good quality, having high strength and durability. The fibre is lustrous and blends very well with wool, silk, cotton, etc. Strong twines, canvas suiting, shirting, carpets and various indispensable products for defence

purposes are manufactured from linseed. After extraction of fibre of linseed the straw is utilized for preparation of straw boards, high grade writing papers and so on. Nevertheless, the rough and strong fibre of linseed is effectively used for preparation of low cost roofing tiles based on convertible polymers. In several countries it is grown for fibre production exclusively. Now, there is more emphasis to evolve double purposesvarieties/cultivars which may be capable of producing seed equal to the best seed type and fibre equal to best flax type in the country (Anonymous 1995, Rai 1999 & Sharma 1999).

In Uttar Pradesh linssed is grown in an area of 0.081 million hectare, out of which 56 per cent of the area lies in Bundelkhand region. The average productivity of linseed in Uttar Pradesh is 450 kg/ha while in Bundelkhand region it is only 375 kg/ha (Singh *et al.* 1998-99).

In Bundelkhand, the crop is mainly grown under rainfed conditions on Mar and Kabar soil on the Conserved Soil Moisture in marginal and Sub marginal lands without applying recommended dose of fertilizers and weed control practices. The linseed crop is also cultivated as mixed with other crops. Farmers of the region often prefer to grow their old varieties and they also not adhere to the correct date of sowing of the crop. These conditions result in low productivity of liseed in this region. Other constraints to productivity is *Utera* or *Paira* cropping of linseed. This is one of the best known dry land practice of utilizing residual paddy soil moisture were tillage is difficult. Linseed is grown in about 25 per

cent of the total linseed area. Under such adverse situations, the average yield is about 150-200 kg/ha which brings down the average productivity to a great extent. The other reasons of fluctuating low production are use of poor quality seeds, non correction of secondary and micronutrient deficiencies and lack of plant protection measures. Besides the above factors, the inherent biological limitations are also responsible for low production. Oilseeds are energy-rich crops, but they are grown under energy-starved conditions. Reddy (1990) reported that one gram of glucose manufactured through photosynthesis produces 0.83 g starch, 0.40 g proteins, but only 0.32 g of fats and oils (lipids). Unless oilseed crops are provided with extra inputs particularly balanced fertilization and micronutrients, one should not expect the same level of production as incase of starch-yielding plants.

According to Tandon and Chauhan (1995), the increase in crop production is the resultant of the integrated approach of the improved technology of crop production like proper time of sowing of crop, use of high yielding suitable improved varieties, plant protection measures, use of balanced fertilizers, irrigation, maintaining optimum plant population and adopting best use of available resources.

No work has been done so far on the performance of group of high yielding improved varieties under different dates of sowing at different level of irrigation under Bundelkhand conditions. Keeping in view the above facts a trial entitled "Studies on the effect of different dates of sowing, varieties and number of irrigations on

yield attributes, yield and quality of linseed (*Linum usitatissmum* L.). The proposed investigation is therefore expected to provide adequate information which may be used profitably by linseed growers for increasing the yield, quality and profit from linseed crop in Bundelkhand of Uttar Pradesh. the trial was conducted for two years at B.N.V. College Research Farm Rath with following objectives:

1. To determine the suitable date of sowing on plant growth, seed yield and seed quality of linseed.
2. To identify a suitable variety for the production of linseed under existing agro-climatic conditions of Bundelkhand region.
3. To find out the suitable number of irrigation for linseed crop to get maximum yield.
4. To study the effect of date of sowing, varieties and irrigation on the growth, yield and quality of linseed.
5. To find out the more beneficial interaction of treatments for maximum return per hectare.
6. To evaluate the total net-monetary gain from various treatment combinations.

REVIEW OF LITERATURE

CHAPTER-II

REVIEW OF LITERATURE

Time of sowing plays an important role in successful harvest and higher yield of harvest, because appropriate sowing time is the most non monetary input contribution towards the maximum yield exploitation of a crop which ensures required quantum.

Optimum time of sowing differs owing to variations in soil and climatic conditions and cropping system adopted. The optimum varies in different agro-climatic conditions from region to region. In peninsular region, this crop is generally sown early whereas in north, this crop is generally sown somewhat late because appropriate sowing time is the most important factor of production.

According to Suman and Rai (1990) and Tomar (1998), the weather prevailing during the growth phases had a considerable influence on seed yield. The crop can be sown for 1st week of October to 4th week of October, it takes longer duration for maturity to other dates of sowings, because of longer duration in October sown crop, the yield attributes recorded significantly higher value and ultimately higher yield but delay in sowing beyond this time adversely affects plant growth and the yield of the crop.

Plants depend for their growth and development firstly on their genetic constitution and secondly on their exposure to variable environment. However, adaptiveness of plants to variable

environmental situation is most desirable. Temperature is the main environmental factor, as well all elementary physiological processes in the plant other than photochemical ones depend on temperature. The time of planting by determining the length and period of growth season creates and environmental condition in which temperature plays the most important role. It would, therefore, be quite natural to expect modification of plant activities and growth process, which are ultimately reflected in the yield and quality of the crop due to different dates of sowing.

Linseed required a cool growing season as reported by lender(1934), Sengupta and Sen(1944), Smith(1946) and Mullar(1952). They observed that temperature control the growth period of rabi oilseed crops and low temperature controls the growth period oilseed crop and low temperature also increase the vegetative period and vice-versa. Linseed crop requires moderate temperature(21-25^0 C) for optimum germination and growth. High temperature about 32^0 C with drought during flowering stage reduce the yield, oil content of the seed and quality of the oil. Garg(1961) recommended that for higher yield of linseed the crop must be sown by mid of October to mid of November in Kota division and Sawai Madhopur of Rajsthan.

Sethi and Sharma (1952) recommended that to get higher yield of linseed in Uttar Pradesh, the crop should be sown by end of October to first fortnight of November.

Majumdar (1962) at IARI, New Delhi reported that the length of siliqua and number of seeds/siliqua in mustard were not significantly influenced by different dates of sowing.

Lahiri (1964) from experiments conducted on mustard at I.A.R.I., New Delhi reported that late sown crop suffered the most in respect of plant height, dry matter production, number of primary branches, number of seeds/silqua, siliqua length and 100 seed weight.

Singh (1968) observed that protein content increased and oil content decreased with delay in sowing beyond end of October.

Saini (1972) reviewed the results of field experiments conducted in mustard at Ludhiana and reported that each fortnight delay in sowing beyond October 15 decreased seed yield by about 12, 36, 53 and 66 percent upto November 30.

Rai and Kumar (1978) reported that in north India mustard sown in first fortnight of October gave higher seed yield and crop sown latter than this period reduced the seed yield of mustard and rapeseed crops due to reduced plant growth, span of flowering and seed formation.

Singh (1978) and Rai (1980) noticed that seed yield per plant in linseed showed positive association with capsules and secondary branches per plant and seed per capsule and ultimately the yield according to sowing dates of the crop. Rai (1982) observed that

timely sowing of linseed not only increased the yield but oil production also.

Delay in sowing of rabi oilseed crops not only reduced seed yield but result in insect pests and plant diseases problem (I.C.A.R., Annual Report, 1983). At Sarkanda Farm, Bilaspur (M.P.) during 1982-84 linseed cultivar J-552 was sown on 10th, 25th of October, 10th November and 10th December. The optimum sowing date was 10th November. Seed oil content decreased and protein content increased as the sowing date was delayed after 10th October.

Kumar and Shastry (1984) at Pantnagar observed that delayed planting of mustard reduced growth and reproductive phases resulting in weaker plant with decreased seed yield.

Singh (1988) reported that October sowing of linseed under rainfed conditions produced higher yield than other dates. Aulok and Bahal (1989) reported that at Ludhina 15th October sown crop produced 2.45 ton while 15th November sown crop produced 1.9 ton/ha linseed seed. Tiwari *et al.* (1988) showed marked improvement in the growth and yield attributes of linseed cultivar Sweta due to N application which proved superior to the local variety.

Shrivastava (1990) suggested that Madhya Pradesh linseed crop should be sown from 1st week of October to 3rd week of October in the regions where winter season is moderate while the

crop may be sown by the 1st week of November where winter season is severe, otherwise delay in sowing will result in poor yield and low production of oil.

Rajput *et al.* (1991) at Morena reported that in late sown rabi oilseed crops, number of branches, dry matter production, seed yield/plant and 1000 seed weight decreased significantly with delay in sowing later than 10th October. Based on multilocation experiments on planting dates conducted over 25 years result concluded are as follows (I.C.A.R. Report on Oilseeds 1967-92):

a) October sowing has been found by and large to the most suited planting time for linseed in most of the linseed growing areas.

b) In upland cultivation highest yields are obtained by planting linseed a little earlier in the 1st fortnight of October in Madhya Pradesh, Maharastra and Karnataka. Second fortnight of October in Gangetic alluvium of Uttar Pradesh and Bihar and 1st fortnight of November in West Bengal.

c) Under assured moisture, highest yields are obtained when linseed is planted in second fortnight of October in Himachal Pradesh.

d) Delay in sowing beyond optimum period reduced linseed yield from 14.0 percent at Gurdaspur (Punjab) to 51.0 percent at Kanke (Bihar) under irrigation, while under rainfed

situation the decrease in yield ranged 25 per cent at Kanke (Bihar).

e) Timely sowing not only gives high yield but also helps to reduce losses, if any, from biotic stresses such as powdery mildew and Alternaria blight in general and insect bud fly (*Dasyneura lini*) in particular.

f) In central and peninsular regions 8-10 days earlier planting escapes bud fly infestation, which is the most serious pest of these areas.

Mahapatra (1993) reported that optimum time of sowing of linseed and mustard mixed in Orissa is from middle of October to 1st of November and sowing beyond this time reduced the seed yield by 25 to 30 percent.

From the experiments conducted under AICOPRO at different locations of India during 1994-95 it was concluded that higher yield of linseed can be obtained if the cop is sown in the 1st week of November, keeping all other inputs of production normal.

Rathore (1995) observed that linseed when sown upto 10th October resulted in higher yield but later sown crop resulted in reduced yield due to insect pests and disease problems.

At Palampur during 1995-96, trials on role of date of sowing under AICORPO it was observed that plant stand, seed, straw and fibre yields were recorded significantly maximized upto 1872.78 kg/ha, 1376.85 kg/ha, 3247.11 kg/ha and 674.67 kg/ha when the

crop was sown on 15th October. All these parameters of linseed wee found lower in 5th October and 30th October sowing.

During 1996-97, effect of date of sowing on linseed trials was conducted at Kanpur, Faizabad and Palampur. Seed yield, straw yield, capsule/plant and test weight were recorded as follows:

Parameters	**15th October**	**25th October**	**5th November**	**C.D. (at 0.5%)**
	Results of trial at Kanpur			
Seed yield (kg/ha)	2158.73	1988.10	1888.89	102.69
Straw yield (kg/ha)	5857.14	6688.89	6971.43	539.54
Test weight (g)	8.79	8.89	8.93	N.A.
	Results of trial at Faizabad			
Seed yield (kg/ha)	1497.53	1419.75	1244.73	32.97
Straw yield (kg/ha)	3575.31	3457.41	2919.14	221.73
Test weight (g)	9.10	8.93	8.46	N.A.
	Results of trial at Palampur			
Seed yield (kg/ha)	1433.80	876.20	799.44	72.44
Straw yield (kg/ha)	3498.33	2982.33	2568.67	112.69
Test weight (g)	7.52	7.53	7.39	N.A.

The above results show that as the date of sowing is extended the yield of seed per hectare is reduced significantly while straw yield/ha is increased at Kanpur as the date of sowing is extended

but at Faizabad and Palampur it is decreased on the extension of the date of sowing the yield of straw is decreased significantly. The test weight of seed at Kanpur increased on the extension of date of sowing but at Faizabad and Palampur the test weight is decreased as the date of sowing is increased.

During the year 1997-98, the trial on effect of date of sowing was conducted with double purpose linseed variety (for seed and fibre) at Kanpur, Faizabad and Palampur under AICORPO. The results are as follows:

a) At Kanpur seed yield increased significantly with 15th October sowing over other dates of sowing but fibre yield was significantly higher with 25th October sown crop.

b) At Faizabad early sowing on 28th October gave significantly maximum seed and fibre yield.

c) At Palampur it was observed that seeding double purpose linseed in the first fortnight of October was optimum to achieve higher yields of both seed and fibre.

In the year 1998-99 trials were conducted at Powarkheda, Raipur and Kanpur under AICORPO to study the effect of date of sowing on double purpose linseed varieties. The results were as follows from the above stations.

Station	Sowing dates			
	8th Oct.	18th Oct.	28th Oct.	7th Nov.
Powarkheda				
Mean seed yield (kg/ha)	1215	1034	1066	885
Mean fibre yield (kg/ha)	379	422	566	653
Raipur				
Mean seed yield (kg/ha)	-	-	1104	364
Mean fibre yield (kg/ha)	-	-	535	241
Kanpur				
Mean seed yield (kg/ha)	-	1544	1441	1333
Mean fibre yield (kg/ha)	-	-	-	-

From the above table it is clear that early sowing in first week or later sowing in October, seed yield produced is significantly higher than November sowing.

During the year 2000-2001 trials on sowing dates were conducted under AICORPO at Nagpur, Raipur and Kanke had shown that sowing time has exhibited that significant influence on seed and fibre yield of linseed. Crop sown upto 1st fortnight of November had produced higher seed yield than the late sown crop, however, fibre yield was found significantly higher in late sown crop upto 28th November.

From above literature, it can be concluded that 1st fortnight of October to 1st week of November was found most suitable time

of sowing for linseed crop and delay in sowing beyond this time adversely affects the plant grown and ultimately the yield.

Effect of date of seeding on seed quality:

The sowing date has also been reported to affect profoundly seed quality of linseed crop. Delay in planting from normal period showed decrease in oil content and increase in protein content in seeds. (Lander 1934 and Smith 1949). Majumdar (1962) and Kumar and Shastry (1984) have reported decrease in oil content and increase in protein content in mustard and yellow sarson seeds also.

Bisnoi and Singh (1979) observed that early sowing of raya increased the oil content. Guan and Zhangteo (1987) reported that delayed sowing of linseed reduced the reproductive period and ultimately affected the oil content in linseed. Almost similar views were reported for mustard by Singh & Singh (1985) and Ghosh and Chatterji (1988).

Payasi *et al.* (1999) observed that seed yield/plant had positive association with capsules and secondary branches per plant and also seeds per capsule affecting the oil percent in linseed crop. Date of sowing also affected the oil content in linseed.

Phalwan and Kapre (2002) recommended that proper time for sowing of linseed in Madhya Pradesh is from 1 weak of October to last week of October. Delay in sowing beyond this will encourage diseases like rust, powdery mildew and attack of bud fly resulting in poor yield of late sown crop.

From the above it may be concluded that sowing time of linseed affect the oil content.

Review on Linseed varieties:

The evolution of varieties in all the major crops has revolutionized the agricultural production throughout the world and oil seed crops particularly linseed is no exception to this phenomenal scenario. Any variety of linseed before being recommended for general cultivation in a region must be judged for its yield potential, tolerance/resistance against diseases, insect pest and response to improved crop production technology, adaptability to different agro-climatic conditions and other important factors which are essential for economic returns. The value of improved varieties has been universally recognized as an important limiting factor for boosting crop yield. How far the varieties differ in their response of yield attributes and yield has been tried by several workers at different places. Large number of high yielding varieties of linseed were released/identified during seventies and eighties for specific regional and multi regional importance for *utera* or *paira* rainfed and irrigated situations and double purpose varieties under good management endowed with other desirable features such as mono/multiple resistance to major biotic and abiotic stresses. How far the linseed varieties developed and their response to various production factors respect to yield attributes

and yield/ha as tried by several workers of different places has been revealed under:

According to Howard and Khan (1924) NP-12, NP-121 and NP-124 (Mutant from NP-12) were recommended for general cultivation being high yielding and more suitable in U.P., Bihar, Bengal and Assam. These were small seeded with low oil content.

Landar (1934) and Smith (1946) had advocated that selection of linseed variety for a region or area depends on its performance with respect to yield of seed, oil and flax under the weather condition prevailing in locality or area during the growth phases. Abnormal weather conditions prevailing particularly during the reproductive phase of the crop will reduce the yield considerably due to insect pest and diseases infestation with short favourable duration for the crop growth and development. Because the linseed crop needs about 25-30° C temperature during germination and about 15-20° C during seed formation while crop for flax (fibre) requires still lower temperature and high humidity.

Sethi and Sharma (1952) reported that varieties T 477 (small seeded) and T-1193 (bold seeded) performed better then local varieties in Jhansi, Varanasi, Gorakhpur, Allahabad and Faizabad division having 37-45% oil.

Despande and Jeswani (1954) reported the superiority of NP varieties (RR-5, RR-9, RR-10, RR-37, RR-38 & RR-45) in Indogenetic plains.

Garg (1961) observed that in Bundi, Kota, Jhalawar, Chittor, Tonk and Sawaimadhopur districts of Rajasthan linseed variety RR-45 produced higher yields with 38-45% oil in seeds than the traditional varieties cultivated by the local farmers.

Chauhan (1963) reported that improved EB-3, IP-6, IP-61 & IP-65, NP-3, and NP-55 and farm white gave higher yields of linseed than brown seeded local varieties in Madhya Pradesh.

Indian Council of Agriculture Research New Delhi has reported (in Research highlight of ICAR from 1967-92) the salient features of linseed varieties released during this period. How far the linseed varieties developed and their response to various production factors with respect to yield attributes and yield/hectare as tried by several workers at different places has been revealed under: How far the varieties differ in their response of yield attributes and yield has been tried by several workers at different places. Large number of high yielding varieties of linseed were released/identified during seventies and eighties for specific regional and multi-regional importance for *utera* or *paira* rainfed and irrigated situations and double purpose varieties under good management endowed with other desirable features such as mono/multiple resistance to major biotic and abiotic stresses.

S. No.	Variety & year of notification	Maturity (days) & situations	Average yield (kg/ha)	Oil per cent	Remark
A.	**Seed varieties:**				
1	LC-54 1982	155-170 irrigated	1320	42	Resistant to powdery mildew, wilt and rust.
2	Himaini 1985	150-175 irrigated & utera	1310	42	Resistant to rust & wilt, tolerant to powdery mildew.
3	Pusa-2 1985	150-155 irrigated	1300	43	Resistant to rust and drought having wide adaptability.
4	Pusa-3 1985	120-125 rainfed	730	42	Highly responsive to fertilizer & irrigation.
		150-155 irrigated	1340	42	
5	Jawahar-23 1985	120 irrigated & rainfed	1000 700	43 43	Resistant to powdery mildew, wilt & rust. Escapes bud fly infestation.
6	Garima 1985	125-130 irrigated	1490	43	Resistant to rust, tolerant to alternaria blight, escapes bud fly infestation, also perf-orms well in delayed sowing, responds to irrigation & fertilizer.
7	Sweta 1985	130-135 irrigated & rained	880	44	Resistant to rust & tolerant to alternaria blight, powdery mild-ew and drought.
8	Shubra 1985	130-135 irrigated & rainfed	1390 870	45 45	Resistant to rust, escapes bud fly infe-station. Oil is exc-ellent for paints, etc.

9	Kiran 1988	130-135 rainfed	730	43	Resistant to rust, wilt & powdery mildew & tolerant to bud fly.
B.	**Double purpose varieties:**				
1	Gaurav 1987	130-140 irrigated	Seed 1050 Fibre 1033	43 43	Resistant to rust & powdery mildew, tolerant to alternaria blight & wilt.
2	LCK-8528 1989	130-135 irrigated	Seed 1233 Fibre 1033	43 43	Resistant to rust and powdery mildew, tolerant to alternaria blight & wilt.
3	Jeevan 1987	175-180 irrigated	Seed 1090 Fibre 1050	42 42	Resistant to rust, wilt, powdery mildew & lodging.
4	KL-31 1988	130-165 irrigated	Seed 1166 Fibre 950	43 43	Resistant to rust, powdery, tolerant to altenaria blight.

Besides the above varieties, some of other promising genotypes resistant to some biotic stresses identified/released during 1962-1992 are listed below:

Wilt- Kangra, NP(RR-65), LHCK-172, KL-86, RLC 38 & 44, LCK 8605 & 8606.

Powdery mildew- KL-1 & 43, LCK 8776, NL-38, RLC-43 & 45, R-552 & several others.

Alternaria blight- KL-31 & 86, Chherapuram, Flax purpose.

Linseed bud fly(0-5% bud infestation only)- NP-8, NP-40, LCK-8326, LCK-88062 & Neela.

Other promising useful genotypes:

Early maturing- R-1863 &1871, LMH-350 & 360, NP-38 (101-110 days).

Drought resistant- LCK-8707, LCK-87131 &87133, GS-344, T-397, Sweta & Kiran.

Resistant lodging- Neelum, LCK-240, LCK-242.

Resistant/tolerant to salt sick soils- Bengal-34, LID-5, NP(RR)-5, LCK-8618 & 8691, RL 2901, NP-32.

High oil content lines (45-48%)- K-2, NP(RR)-208 & 553, Shubhra, Mukta.

Lines with high iodine value (190-195)- NP 124 and Shubhra.

Lines with high linolenic acid (60-65%)- NP-26, NP(Hyb) 8, 34 & 43 and Shubhra.

Lines with low linolenic acid (31-40%)- NP-437, NP(RR) 182, LC-185, Afghan-14.

Besides these varieties, number of states also involved in improvement programme through various research scheme sponsored by I.C.A.R. which helped to identify following improved high yielding varieties were identified- T 397, Hira, Mukta, Neelum, BS-44, Himalini, Raipur-17, Mahoba M-10, C-429, Mayurbhanj, B-37, B-96 during 1956-83 (Jeswani, 1984).

According to Rao (1984) Sweta recorded yield of 883 kg/ha grain which is over 16% higher grain yield under rainfed conditions over best check in U.P., Bihar, West Bengal & Assam state. At

Kanpur during 1983-84 Sweta recorded 952 kg/ha against 805 kg/ha by T-397.

According to Dubey and Mathuria (1984) on comparison with other varieties during 1980-81 and 1983-84 the mean yield kg/ha at different locations was as follows:

Grain yield under irrigated condition (kg/ha)

Location	Shubra	T-397	Neelum
Kanpur	1544	1104	1258
Saraimira	2573	2009	1892
Faizabad	1050	1047	573
Mainpuri	1630	2153	2152

Grain yield under rainfed condition (kg/ha)

Location	Shubhra	T-397
Kanpur	874	805
Mathura	833	554
Varansi	1363	1293
Dholi	932	909
Mean (22 locations)	871	763

According to Ojha (1985) Laxmi-27 (LMH-27) variety of linseed was compared with following varieties in Bundelkhand track of U.P. Their yield was as follows:

Variety	Yield(q/ha)at Amrokh		Yield(q/ha)at Mauranipur	
	1981-82	**1982-83**	**1981-82**	**1982-83**
LMH-27	750	742	1133	1503
T-397	530	867	796	1018
Hira	717	683	852	930

The yield was significantly superior to T-397 and Heera at both places and in both the years. Further the plant height, days to maturity and oil content per cent in these varieties were as follows

LMH-27 45-50cm 110-120days 44.9 per cent

T-397 50-55cm 120-130days 47.7 per cent

Hira 55-60cm 130-140days 43.0 per cent

At Hissar LMH-27 yield was 1632 kg/ha as against T-397 of 14223 kg/ha.

Twari *et al.*(1988) showed marked improvement in the growth and yield attributes of linseed varieties and improved varieties were found superior over local variety. Singh(1988) reported that linseed varieties Neelum, Mukta, LC185, T-397 and Heera are superior in yield and oil content than local varieties both for rainfed and irrigated conditions.

Singh(1978). Reported that linseed varieties Neelum, Heera, Mukta K2 are ready for Harvested within 170-175 days yielding 12-18 q/ha, while variety Himani took 170 - 180 days for maturity and produces only 8-10 q /ha seeds and it is susceptible to frost but

resistant to rust and wilt in linseed growing areas of Uttar Pradesh. Oil content of these varieties varied from 40-45%.

Sharma (1990). Noticed (from different trials conducted at several locations) that variety Neelum with 135-145 days produced 15-20 q seed/ha, Mukta with 125-130 days produced 10-18 q/ha seed, Hira with 135-145 days 12-18 q/ha, B-67 with 120-130 days produced 10-18 q/ha and the variety R-17 with 125-130 days produced 10-16 q seed/ha.

According to Singh and Singh (1991) cultivars Neelum and Shubhra yield was not affected even under alkaline soils than Garima and local cultivars.

Khan *et al.* (1992) reported that improved variety Chandini produced higher yield than local traditional varieties in Pakistan.

According to Tomar and Mishra (1992) in a field trial in 1988-90 at Tikamgarh, linseed variety RLC-6 (improved cultivar) gave higher seed yield and net return than the local variety.

According to Ram (1993) at R.A.C. Farm Kanke following varieties were found superior than local in frontline demonstration. According to yield kg/ha record the varieties were in following order T-397 (565.56 kg/ha mean yield) Sweta (557.04 kg/ha), Shubhra (540.37 kg/ha), BALI-470/B (507.04 kg/ha) and Local (392.75 kg/ha) under rainfed conditions.

During 1994-95 varietal trials were conducted under All India Coordinated Oilseed Improvement Project at following

stations. Both under rainfed and irrigated conditions. Results are as follows:

1. Under rainfed conditions linseed varieties C-429, Kiran, R-552 and RLC-29 were grown at Nagpur, Raipur and Sagar. At Nagpur cultivar Kiran yielded maximum (153 kg/ha) followed by RLC-29 and R-552, at Raipur and Sagar Kiran yielded the highest with mean yield of 649 kg/ha and 897 kg/ha respectively followed by R-552 and RLC-29.
2. Under irrigated conditions at Kanpur Neelum (2219 kg/ha) yielded higher than local and Gaurav but at par with Gariwa (2145 kg/ha). At Palampur variety KL-31 with 1198 kg/ha was significantly superior than KL-1, Janaki and local. This variety was followed by Janaki (1135 kg/ha) KL-1 (848 kg/ha), both were significantly superior than local (352 kg/ha) (AICORPO-Annual Report, 1994-95).

In 1995-96, linseed varieties were used in yield maximization trial under irrigated conditions at Palamour and Kanpur, Nagpur while under rainfed conditions at Raipur, Nagpur and Kanke (Bihar). At Palampur out of Surabhi, Nagarkot Janki and local varieties used in the trial, Nagarkot recorded the maximum yield of 1095 kg/ha. At Kanpur, Garima, Gaurav, Neelum and local varieties were grown. Garima recorded significantly higher yield (1726.75 kh/ha) than Neelum (1473.29 kg/ha) and Gaurav (1168.72 kg/ha) and local (998.77 kg/ha). At Raipur and Nagpur varieties C-

249, Kiran, R-552 and RLC and RLC-29 were used. Out of these varieties cultivar Kiran recorded significantly higher yield (363.49 & 297.89 kg/ha respectively at Raipur and Napur) followed by R 552 recording 350.79 kg/ha and 210.14 kg/ha). At Kanke Cultivar T 397 recorded significantly higher yield (570.00 kg/ha) followed by Shubhra (541.6 kg/ha), Shweta (538.33 kg/ha) and BALL 470/B (517.29 kg/ha) by regular method of sowing.

(AICO RPO-Annual Report- 1995-1996)

During 2000-2001, double purpose linseed variety Rashmi was successfully grown using a seed rate of 67.5 kg/ha at Raipur.

(AICORPO-Annual Report- 2000-2001)

According to Gupta (2001), the overall performance of LC2023 linseed showed 19.19% under irrigated condition while 22-11% under rainfed conditions when compared with LC 54 linseed variety during rabi 1997-98 in Punjab at farmers field. Its yield performance was also 13.81% increased under rainfed situations when studied from 1993-94 to 199798.

According to Phalwan and Kapre (2002) following improved high quality varieties are found promising than the local ones in Madhya Pradesh.

1. Jawahar 17- Flower blue, Mature in 115-123 days yield 10-15 q/ha.
2. Jawahar 23- Flower white, Mature in 120-125 days. Yield 10-12 q/ha (rainfed) 15-18 q/ha (irrigated).

3. Jawahar 552- Flower blue. Mature 110-120 days. 10-12 q/ha. Good under utera.
4. Kiran – Mature in 120 days yield. 10-13 q/ha. Good for late sowing.

Effect of irrigation on growth, yield and quality of linseed:

As reported by various workers, effect of irrigation on the growth development, yield attributes, yield and quality of linseed in given below. Effect of irrigation on some other rabi oilseed crop is also given to have some idea on their yield attributes, and yield.

Howard and Khan (1924) recommended that 1 irrigation 30 days after sowing is enough to support the healthy growth and development of crop. If in the later stages, there is no winter rain, then, one more irrigation at 65 to 70 days after sowing should also be given so that moisture stress in the crop may not reduce the yield. Smith (1946) had also shown the importance of irrigation in linseed crop for higher yield of the crop.

Sethi and Sharma (1952) recommended 2-3 irrigations in linseed varieties T 477 (small seeded) and T-1193 (bold seeded) for higher yield and fibre yield, while Garg (1961) had recommended only 1-2 irrigations in linseed crop grown in Kota division of Rajasthan. El-Dematy and El-Kobbia (1958) noted that the nutrient uptake by flax was greatest between the seedling and flowering stages provided there is no moisture stress. Chauhan (1963) advocated only one irrigation in linseed crop if there was no winter

rain. Otherwise let the crop as rainfed. Maini *et al.* (1964) reported an increse in dry matter production in toria with the application of one irrigation whereas two irrigation had not responded significantly. Raheja(1978) recommended 2 to 3 irrigations in linseed crop otherwise leaves of young plants are poisonous to goats before flowering.

Jorder et al. (1979) observed that irrigation increased primary and secondary branches, siliquae and seed yield per plant over rainfed conditions in mustard.

Drewit (1980), Gupta and Godawat (1981) and koshta and Battawar(1981) had also reported that in linseed crop branching is the most critical stage for irrigation if the irrigation was missed of this stage then the loss in yield could not be compensated for even by providing irrigation at flowering and capsule formation stages.

Linseed responds well to irrigation. Trials conducted at Mauranipur,Raipur and Tikamgarh indicated best response to 2 irrigations at branching and capsule formation stage with yield increase of 37.5 percent (Mauranipur) to 48.9 percent (Raipur) yield over no irrigation (I.C.A.R. DOR Research Highlights 1967-1992).

According to Yousuf *et al.* (1981). The present increase due to one, two and three irrigation was 1.1, 2.2 and 3.0 q/ha respectively over no irrigation in safflower.

Bhardwaj (1983) at Pantnagar concluded that irrigation significantly affected the plant height dry matter accumulation and number of branches at all stage of crop growth over no irrigation in mustard. He further reported that the number of siliquae per plant, number of seeds per siliquae and test weight increased with increasing levels of irrigation from one to two. Tomar et al. (1985) reported that the linseed crop irrigated at branching stage alone or in combination ofwith flowering or capsule formation stage, produced significant superior yield attributes such as plant height, number of branches and capsulews/plant, number of grins/capsule and grains/plant which ultimately produced higher grain yield/plant and per unit area . according to Prasad and Eshanullah (1986) increase in the yield of Varuna Rai was noticed upto two irrigation. A lowest yield of 10.2 and 10.5 q/ha was noticed under rainfed conditions, which was 40.2 and 40.7 percent less as compared to two irrigation at 30 days and 60days after sowing. According to Guna and Zhangto (1987) one irrigation should be given at flower initiation to reduce the effect of moisture strees in flax.

Following irrigation schedules were used by Tomar *et al.* (1985) at Jabalpur on linseed variety Pratibha.

1. No irrigation I.
2. One irrigation of branching stage I_1.
3. One irrigation of flowering stage I_2.

4. One irrigation capsule formation I_3.
5. Two irrigations at branching flowering stage I_4.
6. Two irrigations at branching of capsule formation I_5.
7. Two irrigations at flowering + capsule formation I_6.
8. Three irrigations at branching + flowering + capsule formation I_7.

These irrigation schedules were observed for two years and then following conclusion was noticed. Irrigation scheduled at branching alone (I_1) or in combination with flowering or capsule formation stages (I_4, I_5 and I_7) were significantly superior to the rest of the irrigation schedules with respect yield attributing characters viz. plant height, primary branches/plant, capsules/plant, grains/ capsule, number of grains and weight of grains/plant. Consequently, grain and straw production/ha were also higher with these schedules of irrigation.

Singh (1989). Advocated that although linseed is a crop of *barani* area, nevertheless, it responds well to irrigation. Two irrigations are sufficient to obtain good yield. 1st irrigation should be given 30-40 days after sowing and 2nd at the stage just before flowering. If there is winter showers than the crop needs no irrigation.

Sharma (1990) recommended that 1st year irrigation for growth should be given 30 days after sowing and 2nd before flowering otherwise the yield of linseed crop is affected if 2nd

irrigation is not given. Shrivastava (1990) recommended that the linseed crop might be irrigated according to the availability of irrigation. If only one irrigation is available, then, irrigate the crop 55 days after sowing and first at 35 to 40 days after sowing and 2nd at 75-80 days after sowing if facility for two irrigation is available. Ghatok *et al.* (1990) reported that the yield of linseed was 407, 452 and 499 kg/ha at Kalayani with 1, 2 or 3 irrigations.

Thosar *et al.* (1990) reported that at Nagpur linseed seed yield due to number of irrigation was as follows: 594 kg/ha under rainfed condition. 819 when one irrigation was given before sowing followed by 2nd at flowering and 3rd at seed filling. 793 kg/ha was produced when the crop was given one irrigation before sowing, followed by second irrigation at flowering. Number of capsules/plant, number of seeds/capsules and test weight were highest with three irrigations. According to Katole and Sharma (1990), at Borekheda Kota (Rajasthan) average seed yield of linseed was highest with irrigation at branching and Capsule development (1.13 tonne/ha) than rainfed condition.

According to Singh *et al.* (1991) irrigation at seeding stages four weeks after sowing and then at branching gave higher yield then one irrigation at seeding stage and rainfed conditions. According to Mandal *et al.* (1991) irrigation creates thje capsule/plant in linseed but not seeds/capsule and one thousand grain weight. Jibhakate and Jaipurkar (1991) at Nagpur found

highest average yield of linseed was maximum (0.82 tonne/ha) when the crop irrigated at pre-sowing. Flowers initiation and grain filling, followed by pre-sowing + flower initiation and the lowest was at rainfed condition.

Zaman and Das (1991) reported that three irrigations at branching, flowering and seed development stages increased the seed yield of safflower 200 per cent over control. Oil content increased from 28.5 per cent with no irrigation to 29.3 per cent with three irrigations.

According to Ram (1992) reported that seed yields of linseed varieties under irrigated conditions in Palamau district ranged between 650 kg/ha to 675 kg/ha with increase in yield upto 227 per cent over farmers local method, whereas it varied from 300 kg/ha to 460 kg/ha under rainfed conditions recording 200 per cent increase in yield.

Dube and Singh (1994) observed at Lahhoti (U.P.) that linseed cultivar Neelum averaged 1.04 ton/ha without irrigation and 1.59 and 1.32 ton/ha with two and three irrigations. During 1993-94 and 1994-95 to identify best variety under irrigated and rainfed conditions. Kiran, RLC-46 and RLC-29 were the varieties which were given I_1 (no irrigation), I_2 (irrigation at 30 DAS), I_3 (irrigation at 50 DAS), I_4 (irrigation at 35 and 70 DAS), I_5 (irrigation at 70 DAS) highest significant seed and straw yield was recorded by I_4 followed by I_2, I_3 and I_5 irrigation significant over

I_1. In the same order of significance number of capsules/plant, number of seeds/capsule and test weight (g) were also recorded. As regards variety RLC-46 followed by Kiran were significantly superior than RLC-29 (AICORP Anuual Report 1993-94 and 1994-95).

Similar trial was conducted during 1995-96 at Raipur with the same varieties. Here also levels of irrigation significantly influenced seed yield. Irrigating linseed at 35 and 70 DAS (I_4) gave significantly maximum yield (910.05 kg/ha) over control and irrigation at 70 DAS. It is followed by the seed yield 882.01 and 803.70 kg/ha, which were received when crop was irrigated at 30 DAS and 50 DAS respectively (AICORP Annual Report 1995-96).

According to Malik *et al.* (1996) irrigating the linseed crop at branching and capsule formation stage resulted in the lowest bud infestation and highest production of linseed per hectare in comparison to plots receiving non or one irrigation. Linseed cultivar RL-50-2 was irrigated at (1) 65 and 90 DAS (2) 40 and 90 DAS (3) 40 and 65 DAS. Oil and fibre yield was highest at irrigation 40 and 65 DAS.

Rathore (1995-96) reported that according to availability of irrigation in Kota division of Rajasthan, the linseed crop is irrigated (1) 35-40 DAS (2) 75-80 DAS. But if only one irrigation is available, then, the crop must be irrigated 55 days after sowing. Response of linseed to irrigation levels trial was conducted during

1996-97 at Raipur, Kanpur and Gurdaspur with different varieties of each centre. Yield of seed per hectare and some other parameters recorded at these centres are given below when irrigation levels are symbolized as I_0 (no irrigation), I_1 (irrigation at 30 DAS), I_2 (irrigation at 50 DAS), I_3 (irrigation at 70 DAS) and I_4 (irrigation at 35 and 75 DAS).

Parameters	Mean yield q/ha					Difference
	I_0	I_1	I_2	I_3	I_4	
Raipur						
Seed yield (q/ha)	799.09	1457.60	1049.43	872.56	1652.61	Significant
Primary branches/plant	2.12	3.09	2.91	2.57	3.29	
Capsule/plant	20.10	29.51	26.44	23.82	32.20	
Seeds/capsule	7.37	7.86	7.61	7.59	8.18	
Test weight (g)	5.39	5.97	5.42	5.37	6.16	
Kanpur						
Seed yield (q/ha)	1313.49	2023.81	2257.94	1888.89	2214.29	Significant
Primary branches/plant	4.33	5.66	5.33	5.33	5.66	
Test weight (g)	7.29	7.34	7.27	7.24	7.37	
Oil content (%)	40.02	39.28	39.16	40.14	40.71	
Gurdaspur						
Seed yield (q/ha)	504.27	591.91	601.24	567.47	-	N.S.
Primary branches/plant	2.86	2.89	2.73	3.09		
Capsule/plant	34.67	38.38	37.60	39.64		
Seeds/capsule	7.50	8.41	7.45	8.22		
Test weight (g)	6.05	6.02	5.62	5.73		
Oil content (%)	37.7	37.9	39.6	37.6		

It is clear now from the above that I_4 and I_2 and I_3 levels of irrigation were better than I_0 with respect to seed yield, primary branches/plant and capsule/plant were recorded higher in I_4 and I_1 level at Raipur and Gurdaspur while seeds/capsule were higher in I_1 and I_4 levels of irrigation at Raipur and Gurdaspur. Test weight was also recorded higher in I_1 and I_4 levels at Raipur and Kanpur but at Gurdaspur I_0 and I_1 had recorded more test weight than I_2 and I_4. oil content percent in seed was more in I_3 and I_4 levels of irrigation at Kanpur while at Gurdaspur I_2 level had more oil content than all other levels, which had almost similar oil content percent(AICORP Annual Report 1995-96).

Rathore (1995) reported that two irrigations in linseed 1st at 40-45 days after sowing and 2nd irrigations given 60-75 DAS in Kota division of Rajsthan produced per hectare 14-15 q seed and 10-11 q fibre in double purpose cultivar LCK-8579. According to Singh *et al.*(1999) at Faridabad 2,3 and 4 irrigations given to linseed culivar Garima it was found that yield and yield components and oil content were recorded higher with four irrigations.

Nagraya *et al.*(1996) at Hebbal(Karnatak) reported that two irrigations given in linseed in following ways;

1. One at flowering +2nd at capsule development
2. One at branching +2nd at capsule development
3. One at branching +2nd at flowering

Out of the above three schedules 3rd schedule that is two irrigations at 40 and 65 days after sowing produced highest seed, straw, fibre and oil yields. At this schedule there was highest moisture extraction from 0-30 cm soil layer. They further noticed that water stress at branching (10-40 days) and flowering (stage (41-75 days) decreased seed yield.

Agrawal *et al.* (1997) reported (College of Agriculture Engineering, Jabalpur) that two irrigations at 30 and 60 DAS significantly produced higher seed yield than one irrigation given at 30 DAS and no irrigation during the years 1989-90 and 1990-91. linseed crop irrigated twice at 30 and 60 DAS offered higher net returns as compared to those obtained under one irrigation and no irrigation. Cost of production for per unit produce under two irrigations was Rs 4.20/kg against Rs. 4.70/kg with one irrigation and Rs. 5.10/kg with no irrigation. Thus two irrigations resulted in maximum benefit cost ratio (2.50) as compared to 2.25 and 2.10 under one irrigation and no irrigation respectively. this indicates that increased cost of cultivation due to irrigation helped to increase proportionately the seed yields. The energy output was also higher with two irrigations (16370 MJ/ha) against one irrigation (13968 MJ/ha) and no irrigation (12187 MJ/ha). The energy output is directly related to seed yield, therefore, the mean yield of two years in no irrigation was 487 kg/ha, 559 kg/ha in one irrigation 655 kg/ha in two irrigations. The difference in yield is

significant in both the years. Vivek *et al.* (1998) reported that high yields can be obtained in sunflower when irrigation is applied at proper time.

From multilocation testing of linseed varieties in cultivators field from 1993 t0 1998. Gupta (2001) reported that cultivar LC 2023 gave an increase of 17% and 44% under irrigated and rainfed situations in Punjab. He further reported that in 10 adoptive trials (6 irrigated + 4 rainfed) conducted by Farm Advisory Service Punjab Agriculture University LC 2023 linseed recorded an increase of 7.7 and 7.04 percent over the check cultivar LC 54 under irrigated and rainfed conditions.

Phalwan and Kapre (2002) noticed at J.N.K. Vishwa Vidyalaya, Jabalpur that in linseed first irrigation should be given 35-40 days after sowing followed by 2^{nd} irrigation at 75-80 DAS. No further irrigation will have no economic advantage.

Effect of irrigation on quality and oil content:

Howard and Khan (1924), Johnson (1932) and Despande and Malik (1937) had observed that yellow seed colour varieties if judiciously irrigated and all other inputs are judiciously given to them will have high oil content than the other seed colour varieties under the same conditions.

Dillman and Hopper (1943) found that large seeded varieties gave 2-3 percent more oil over small seed varieties both in rainfed and irrigated conditions. Judicious use of irrigation, harvesting at

proper stage of maturity would certainly result in desirable qualities in linseed seed with high oil percent. Gupta (1962) reported that in linseed crop optimum oil content was formed 30 days after flowering.

Pandey *et al.* (19) reported that increasing levels of irrigation significantly increased the height of plant, seed and straw yield and total oil yield q/ha. irrigation at 30 days (I_1) and at 60 days (I_2) after sowing increased the seed yield significantly over no irrigation (I_0) but difference among I_1 and I_2 was not significant. Increase in seed yield and oil yield q/ha due to the application of irrigation water may be due to the fact that water helps in better utilization of nutrients in the soil. Khan (1980) observed that irrigation did not influence the oil and protein content but it had marked effect on oil yield.

Khan and Agarwal (1985) observed that irrigation level have no effect on oil and protein content in seed and iodine value in oil. Padmini *et al.* (1992) found in field trials in mustard that the oil content of seed showed slight increase with irrigation. Singh *et al.* (1994) reported that application of 1 and 2 irrigations on an average increased the oil yield by 21.42 and 27.55 when compared with no irrigation respectively in mustard. Irrigation did not influenced protein content.

Vivek *et al.* (1994) reported that in sunflower oil content is affected due to variation in soil moisture especially in reproductive

phase. Kumar and Prasad (2001) recorded maximum seed yield at 3 irrigations, significantly higher then 1 or 2 irrigations in sunflower. The maximum seed oil content was recorded with one irrigation where as maximum oil yield with 3 irrigations. This might be due to better filling seeds as a result of less moisture-stress conditions at the critical stages of seed filling.

MATERIAL AND METHODS

CHAPTER-III

MATERIAL AND METHODS

A standard technique of study and careful selection of materials used are the prime importance for obtaining high precision from the results of an investigation. In this investigation, therefore, these were used after a through consideration of different objects to be derived from the results. A detailed account of materials used and methods followed during the present investigation "Studies on the effect of different dates of sowing varieties and number of irrigations on yield attributes, yield and quality of linseed (*Linum usitatisimum* L.) under Bundelkhand conditions" are given in ensuing chapter.

Location:

In both the years of study the field experiments were conducted at Brahamanand Mahavidhyalaya Research Farm Rath (District – Hamerpur) U.P. during rabi season of 1998-99 and 1999-2000. The Research Farm is situated in the southern part of Uttar Pradesh in Bundelkhand region at latitude 79.7° East and at longitude 25.5° North at and elevation of 175.5 m from sea level. The trial was conducted in the field which has assured irrigation facilities and good drainage with moderate slope in one direction from east to west.

Climate and weather conditions:

Bundelkhand has sub-tropical climate with extreme hot days in summer and cold in winter. The average annual rainfall varies between 800-900 mm which is mostly received during the last June

to September months. While the small fraction of rainfall may also occur during winter months. The mean monthly temperature (maximum and minimum), relative humidity (maximum and minimum) and total rainfall as recorded at the Meteorological Observatory are given in table-1 & 2 and depicted in figure 1 & 2.

Table-1&2: Meteorological data during rabi seasons of 1998-99 & 1999-2000.

Year & Months	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Number of rainy days
	Max.	Min.	Max.	Min.		
1998-99						
October 98	33.77	20.90	88.50	48.25	-	-
November 98	29.85	13.70	86.50	47.00	-	-
December 98	25.94	6.92	90.00	33.00	-	-
January 99	21.55	5.67	95.50	52.25	2.05	7
February 99	25.42	9.02	91.25	34.00	-	-
March 99	33.05	11.72	78.75	24.13	-	-
April 99	37.85	18.73	71.34	17.10	-	-
1999-2000						
October 99	31.90	17.90	91.00	46.00	-	-
November 99	29.60	10.42	88.00	32.00	-	-
December 99	24.31	6.50	94.00	38.00	-	-
January 2000	24.30	6.70	92.00	37.00	-	-
February 2000	25.60	7.70	91.00	36.00	-	-
March 2000	32.32	11.50	84.00	29.00	-	-
April 2000	40.50	20.40	61.00	19.00	1.5	2

The weather data given in Table-1 & 2 were found normal for the linseed crop during two crop seasons of field experimentation.

FIG. 1: METEOROLOGICAL DATA DURING RABI SEASON 1998-1999

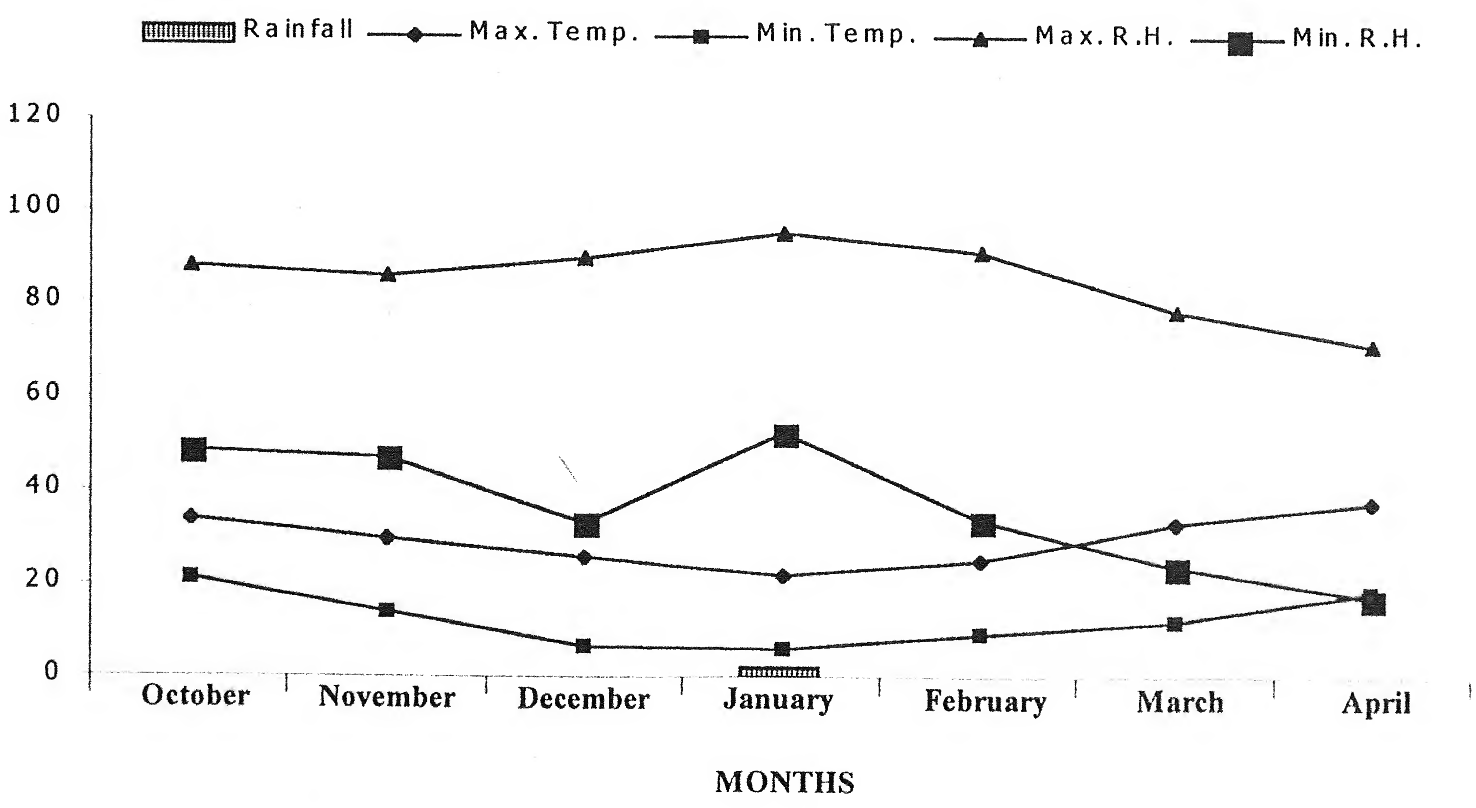
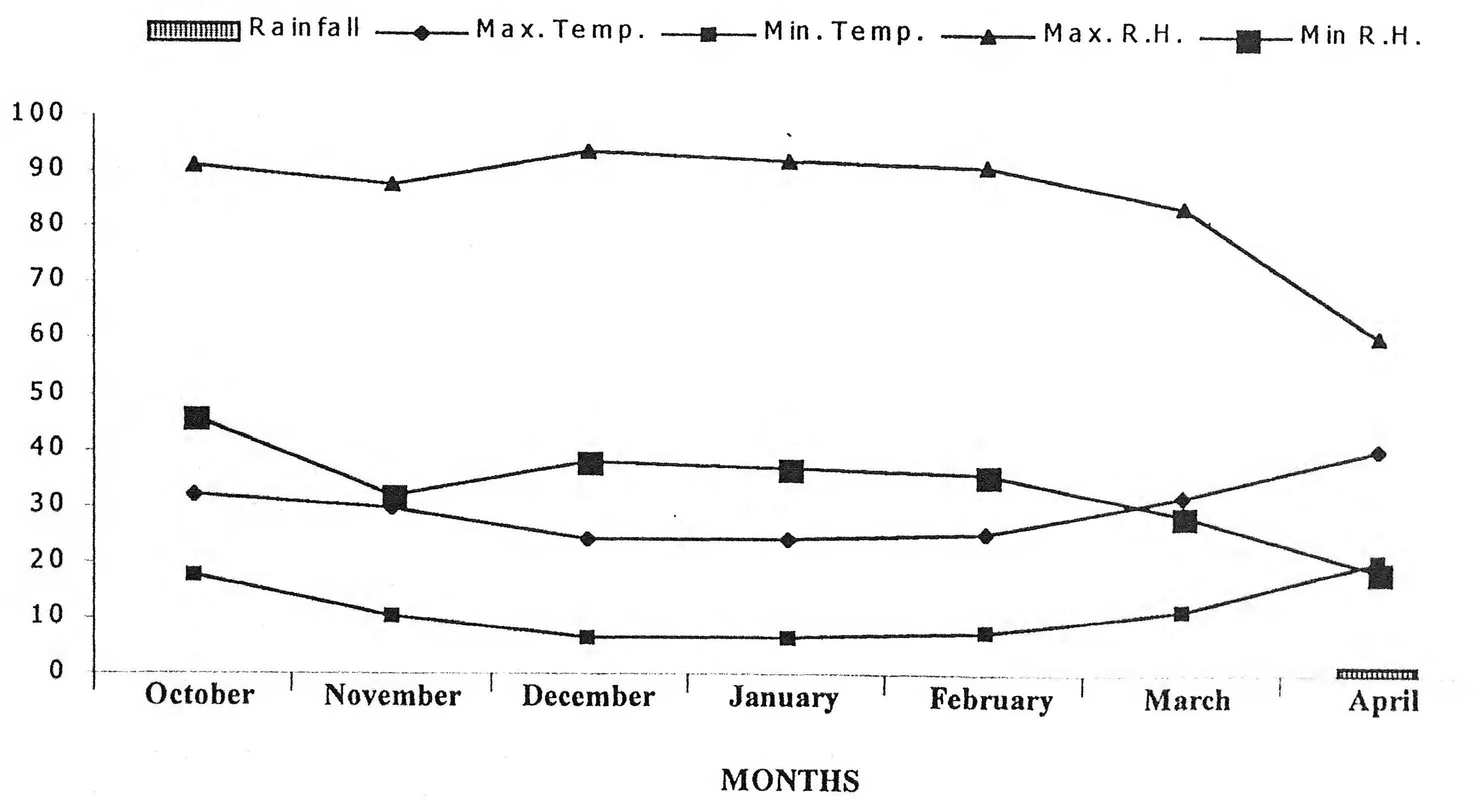


FIG. 2: METEOROLOGICAL DATA DURING RABI SEASON 1999-2000



Previous cropping history of the field:

The cropping programme for the experimental plot for the year 1998-99 and 1999-2000 respectively followed during the last four years proceeding to the experiments is furnished in table-3.

Table-3: Previous history of the field.

S.No.	Year	Kharif	Rabi	Zaid
1	1994-95	Moong	Wheat	-
2	1995-96	Jowar chari	Mustard	Moong
3	1996-97	Soybean	Wheat	-
4	1997-98	Urd	Wheat	Jowar chari
5	1998-99	Moong	Present experiment of (Linseed)	
6	1999-2000		Present experiment of (Linseed)	

In the both the years trial the linseed crop was sown in the same field.

Soil:

The experimental field of the trial was locally called Paduva in Bundelkhand. The composite soil samples were collected from the experimental field from 0-15 cm depth, with the help of khurpi and soil auger. Then the samples were analysed in the soil testing laboratory, for various physical, chemical and physico-chemical characters. The estimate and methods employed in their determination are presented in table-4 & 5.

Table-4: Physical characteristics (Mechanical composition of soil).

S.No.	Soil component	Percent Value Obtained		Method of determination
		1998-99	1999-2000	
1	Sand	28.25	28.15	International Pipette Method
2	Silt	50.15	50.27	(Piper 1950)
3	Clay	21.60	21.58	
4	Texture	Silty loam (Paduva)		

Table-5: Chemical characteristics of soil.

S.No.	Particulars	Value Obtained		Method of determination
		1998-99	1999-2k	
1	Available Nitrogen (kg/ha)	0.062	0.065	Alkaline Permanganate Method (Subbiah and Asija 1956)
2	Available Phosphorus (kg/ha)	17.87	18.15	Olsen's Method (Olsen *et al.* 1956)
3	Available Potassium (kg/ha)	182.3	185.7	Flame Photometer (Muhuore *et al.* 1965)
4	Organic carbon	0.53	0.57	Walkly & Black's Rapid Titration Method 1965
5	Electrical conductivity (mm hos/cm)	0.34	0.33	Solubridge Method (Richard 1954)
6	Soil pH	7.6	7.3	Blackman's Glass Electrode pH Metre (Muhuora *et al.* 1965)

A perusal of data reveal that the soil of the experiment plot was silty loam known as Paduva in the region. The soil pH was varying from 7.6 to 7.3 showing that there was no salinity problem. The soil was level form in topography with good drainage.

Experimental technique:

The field experiment was conducted in 'Single split pot design' and replicated three times, with date sowing in main plot while variety and irrigation were in subplot. Each replication had 36 treatments, thus the total number of experimental plots were 108. The allocation of various treatments and their symbols used are given in table-6. The plan of layout is given in figure-3.

Table-6: Treatments and their symbols.

Treatments	Symbols used
(A) Dates of Sowing	
1) 10 October	D_1
2) 25 October	D_2
3) 10 November	D_3
(B) Varieties	
1) Shubhra	V_1
2) Neelum	V_2
3) Sweta	V_3
4) Laxmi-27	V_4
(C) Number of irrigations	
1) One irrigation at 30 days after sowing	I_1
2) Two irrigation, one at 30 days after sowing and 2nd irrigation 60 days after sowing	I_2
3) Three irrigations, one at 30 days, 2nd at 60 days and 3rd at 90 days after sowing.	I_3

Details of the experiment:

(a) Experimental design : Split plot

(b) Total number of treatments : 3 x 4 x 3 = 36

(c) Number of replications : 3

(d) Total number of plots : 3 x 36 = 108

(e) Main plot : 3 (dates of sowing)

(f) Sub plot : 12 (Combinations of 4 varieties and 3 levels of irrigation)

(g) Size of plot

Gross : 3.0 x 2.4 m = 7.2 m^2

Net : 2.6 x 1.8 m = 4.68 m^2

(h) Block border : 1.0 m

(i) Plot border : 0.5 m

(j) Irrigation channel : 1.5 m

(k) Field border : 1.5 m

(l) Replication border : 1.5 m

(m) Total experimental area : 52.5 x 29.6 m = 1554.00 sq m

Table-7: Details of treatment combination

S.No.	Combinations	S.No.	Combinations
1	$D_1V_1I_1$	19	$D_2V_3I_1$
2	$D_1V_1I_2$	20	$D_2V_3I_2$
3	$D_1V_1I_3$	21	$D_2V_3I_3$
4	$D_1V_2I_1$	22	$D_2V_4I_1$
5	$D_1V_2I_2$	23	$D_2V_4I_2$
6	$D_1V_2I_3$	24	$D_2V_4I_3$
7	$D_1V_3I_1$	25	$D_3V_1I_1$
8	$D_1V_3I_2$	26	$D_3V_1I_2$
9	$D_1V_3I_3$	27	$D_3V_1I_3$
10	$D_1V_4I_1$	28	$D_3V_2I_1$
11	$D_1V_4I_2$	29	$D_3V_2I_2$
12	$D_1V_4I_3$	30	$D_3V_2I_3$
13	$D_2V_1I_1$	31	$D_3V_3I_1$
14	$D_2V_1I_2$	32	$D_3V_3I_2$
15	$D_2V_1I_3$	33	$D_3V_3I_3$
16	$D_2V_2I_1$	34	$D_3V_4I_1$
17	$D_2V_2I_2$	35	$D_3V_4I_2$
18	$D_2V_2I_3$	36	$D_3V_4I_3$

Field Preparation:

One ploughing was done by soil turning plough followed by two harrowing and planking were done to make the soil loose and friable for proper and timely germination each year in September. The field was treated clod free and weed free condition each year before sowing.

Fertilizer:

60 kg N, 30 kg P_2O and 30 kg K_2O per hectare was applied through urea, super phosphate single and murate of potash. Half dose of nitrogen and full dose of phosphorus and potassium were applied at the time of sowing by plough sole placement method and remaining half dose of nitrogen was applied after irrigation 30 days after sowing of the crop.

Pre sowing seed treatment:

The seeds were thoroughly cleaned and the desired quantity of seed of each variety was treated with Thirum (Tetra methyl thirum disulfide) @ 3 g/kg seed just before sowing to control seed borne diseases and for better germination.

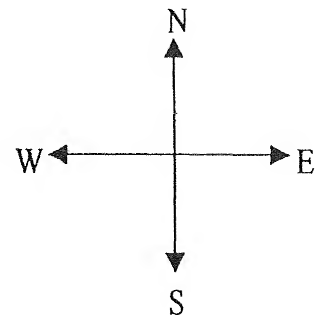
Seed sowing:

The experimental plots were demarcated according to the layout done in the field. Then properly graded seeds of four varieties of linseed viz. Shubhra, Sweta, Neelum and Laxmi-27 sown at the rate of 30 kg seed/ha. Sowing was done by desi pough at 30 cm row to row spacing. The depth of the seeds was kept 2.5 cm in the soil. After showing the seed, channels for irrigation were made manually.

Layout:

As per plan the layout was done on 9^{th} October in both the years.

FIG. 3: LAY OUT PLAN



	Replication I						Replication II						Replication III					
	Field border																	
Field Border			Irrigation Chanal			Replication Border			Irrigation Chanal			Replication Border			Irrigation Chanal			Field Border
	$D_2V_1I_1$	$D_2V_1I_3$		$D_2V_3I_2$	$D_2V_2I_2$		$D_1V_4I_2$	$D_1V_2I_2$		$D_1V_2I_3$	$D_1V_3I_1$		$D_3V_2I_2$	$D_3V_1I_1$		$D_3V_1I_3$	$D_3V_3I_3$	
	$D_2V_4I_1$	$D_2V_3I_3$		$D_2V_4I_3$	$D_2V_2I_3$		$D_1V_1I_3$	$D_1V_3I_3$		$D_1V_2I_1$	$D_1V_4I_3$		$D_3V_2I_3$	$D_3V_4I_1$		$D_3V_3I_1$	$D_3V_1I_2$	
	$D_2V_4I_2$	$D_2V_2I_1$		$D_2V_3I_1$	$D_2V_1I_1$		$D_1V_1I_1$	$D_1V_1I_2$		$D_1V_4I_1$	$D_1V_3I_2$		$D_3V_2I_1$	$D_3V_4I_2$		$D_3V_4I_3$	$D_3V_3I_2$	
	$D_1V_2I_2$	$D_1V_2I_3$		$D_1V_4I_2$	$D_1V_3I_2$		$D_3V_2I_3$	$D_3V_2I_2$		$D_3V_1I_1$	$D_3V_4I_1$		$D_2V_3I_2$	$D_2V_3I_1$		$D_2V_1I_3$	$D_2V_4I_1$	
	$D_1V_1I_3$	$D_1V_4I_3$		$D_1V_3I_1$	$D_1V_1I_1$		$D_3V_1I_3$	$D_3V_3I_1$		$D_3V_3I_3$	$D_3V_1I_2$		$D_2V_1I_1$	$D_2V_1I_2$		$D_2V_3I_3$	$D_2V_2I_3$	
	$D_3V_3I_3$	$D_3V_2I_1$		$D_3V_1I_1$	$D_3V_1I_2$		$D_3V_2I_1$	$D_3V_1I_2$		$D_3V_4I_3$	$D_3V_3I_2$		$D_2V_2I_1$	$D_2V_4I_2$		$D_2V_2I_2$	$D_2V_4I_3$	
	$D_3V_4I_2$	$D_3V_1I_3$		$D_3V_2I_1$	$D_3V_2I_3$		$D_2V_2I_2$	$D_2V_3I_2$		$D_2V_4I_3$	$D_2V_4I_2$		$D_1V_3I_2$	$D_1V_4I_3$		$D_1V_1I_3$	$D_1V_2I_3$	
	$D_3V_3I_3$	$D_3V_4I_1$		$D_3V_3I_1$	$D_3V_1I_2$		$D_2V_2I_1$	$D_2V_1I_2$		$D_2V_3I_3$	$D_2V_4I_1$		$D_1V_1I_2$	$D_1V_2I_2$		$D_1V_1I_1$	$D_1V_4I_1$	
	$D_3V_3I_2$	$D_3V_1I_1$		$D_3V_4I_3$	$D_3V_2I_2$		$D_2V_1I_3$	$D_2V_4I_1$		$D_2V_1I_1$	$D_2V_2I_3$		$D_1V_3I_3$	$D_1V_3I_1$		$D_1V_4I_2$	$D_1V_2I_1$	
	Field border																	

Table- : Details of the operation

S.No.	Operations	Dates	
		1998-1999	1999-2000
1	One Ploughing	4.10.98	5.10.99
2	1^{st} harrowing & planking	5.10.98	6.10.99
3	2^{nd} harrowing & planking	7.10.98	8.10.99
4	Layout	9.10.98	9.10.99
5	Sowing		
	a. 1^{st} sowing	10.10.98	11.10.99
	b. 2^{nd} sowing	25.10.98	26.10.99
	c. 3^{rd} sowing	10.11.98	11.11.99
6	Irrigation		
	a. Irrigation in 1^{st} sowing	10.11.98	11.11.99
	b. Irrigation in 2^{nd} sowing	10.12.98	11.12.99
	c. Irrigation in 3^{rd} sowing	9.1.99	10.1.2000
7	Top dressing of urea		
	a. Top dressing in 1^{st} sowing	4.12.98	5.12.99
	b. Top dressing in 2^{nd}	4.1.99	5.1.2000
	sowing	4.2.99	5.2.2000
	c. Top dressing in 3^{rd} sowing		

Post sowing operation :

1. Thinning was doe once at 25 days are in plots of different sowing dates.
2. One manual weeding was done in each plot 35 days age of the crop plants.
3. On spraying of insecticide Indosulphan was done at 60 days age of the crop plants.
4. Remaining half dose of nitrogen was applied by top dressing in each plot 35 days after sowing.

Harvesting:

Linseed gets ready for harvest according to the maturity days of the variety. As the ripening approaches, crop foliage becomes yellow and progresses to brownish colour when fully mature. The crop was harvested on following dates yearwise:

In 1st sowing harvesting was done on 7.3.99 in 1998-99 and on 5.3.2000 in 1999-2000.

In 2nd sowing harvesting was done on 16.3.99 in 1998-99 and on 15.3.2000 in 1999-2000.

In 3rd sowing harvesting was done on 21.3.99 in 1998-99 and on 23.3.2000 in 1999-2000.

Salient features of the varieties used in the experiment:

Shubhra:

This variety was tested under the name of LHCK-21 and it was developed by Chandra Sheker Azad University of Agriculture & Technology, Kanpur. It is derivative of the cross between Mukta and K_2 and widely adaptable and versatile under both irrigated and rainfed conditions. Grain brown coloured medium bold in size. Its plant is 45-65 cm high erect, compact. Its early growth is fast with crimpled white with pale blue tinge. Capsules of this variety are medium bold. Early maturity within 133-135 days after sowing and due to this fact escapes linseed bud fly attack. Resistant to rust and moderately resistant to Alternaria blight and wilt. It can withstand frost and withstand moisture stress. Respond well upto 90 kg N/ha under irrigated conditions and 40 kg N/ha under rainfed conditions. Oil content 44.47%, Protein content 12.8%, Iodine value 194.3,

Linolenic acid 60.3. Due to its excellent oil content most suited for paints and varnish. Suitable for general cultivation in entire linseed growing areas of Uttar Pradesh, Bihar, West Bengal and Assam both under irrigated and rainfed conditions. Its minimum yield is 903 kg and maximum yield 2573 kg/ha with a mean yield of 8 linseed growing centres 1305 kg/ha.

Sweta:

This variety was tested under the name of LHCK-131 and was developed by Chandra Sheker Azad University of Agriculture & Technology, Kanpur. It is derivative of the cross between Mukta and T-1206. Its grain are medium in size, uneven light brown in colour. Plant open erect 45-65 cm in height. Leaves narrow primary branches developing with wide angle. Flowers open white in colour and medium in size. Mature in 128-140 days. This variety id resistant to frost and linseed rust but moderately resistant to powdery mildew and Alternaria blight, susceptible to wilt. Its capsules are non-dehiscent. Responds well to medium fertility under rainfed conditions. It perform best when sown by the end of October. Due to stiffness in stem, it resists lodging. Most suitable to utera conditions. Oil content is 43.7 percent, Protein content 11.9% percent, Iodine value 173.9 and Linolenic acid 50.0. suitable for general cultivation on linseed growing areas of Uttar Pradesh (excluding Bundelkhand) Bihar, West Bengal and Assam states. Minimum yield is 510 kg/ha and maximum yield of 1286 kg/ha while mean average of 9 locations is 883 kg/ha.

Neelum:

This variety is a cross of T_1 and R.R. 9 and released by Uttar Pradesh State Release Committee. It is a erect, compact with more or less synchronous basal

branching, with medium tall (70-80 cm) plants. Its early growth is vigorous. Flowers are large with overlapped liliae coloured petals. 50 per cent flowering occurs in 75-80 days. Its capsule are bold oval shaped with light brown colour. Late maturity variety (140-145 days). Resistant to rust and tolerant to wilt disease. This variety is highly input responsive variety and yielded as much as 31.5 q/ha. however the optimum requirement is 90 kg N/ha, 30 kg P/ha fertility level. Do well at 25 cm spacing under irrigated situations. Its mean oil content is 41.64%, Protein content 15.6%, Iodine value 180.2, Linolenic acid 51.9. Highest yield at potato fertility 3135 kg/ha, minimum yield 1113 kg while AICORPO trial yield is 1255 kg/ha. Its optimum sowing time is 3rd week of October. Suitable for all linseed growing areas of India.

Laxmi-27:

This variety was released in 1985 and was tested under the name LMH-27. Its parents selection from a multiple cross involved Neelum / KP_1 / Neelum / NP (RR9) / Neelum / RT/ Neelum/Afg*. Its plant is medium dwarf and branches are produced from mid of the stem. Flower colour is blue, seed is brown. It is resistant to rust, powdery mildew and wilt diseases. Its seeds are bold 9 g/1000 seeds). It is early maturity (110-120 days) and posses high oil content (44.9%). It is recommended both for rainfed areas (10-12 q/ha seed yield) and also for irrigated areas (16-18 q/ha seed yield). Most suited for rainfed areas of Bundelkhand region of Uttar Pradesh. Its plant height is 45-50 cm. This variety is also tolerant to bud fly (*Dassynaura lini*). The leaves of this variety are wide, thick and parrot green in colour. Capsules are bold in size.

Biometrical Observations :

Three plants were selected randomly from each plot area and then observations of growth characters were recorded. Following growth characters were studied:

(A) Pre harvest Studies :

1. Population Count :

Plant population from each plot was recorded by counting the number of plants per meter length randomly from three places in each plot in the beginning 30 days after sowing and then just before harvesting.

2. Height of plants :

Five mother shoots were tagged were used for his. After tagging, the height was measured from ground surface to the base of top most axis at 30 days interval and 30, 60 and 90 days after sowing and at harvest. The data was recorded at all these days after sowing.

3(a). fresh weight of plant (g) :

Five plants were randomly selected n each plot and these are removed from ground level weighed and then average fresh weight was calculated in gram at 30 days interval our times.

3(b). Dry weight of plants (g) :

After recording the fresh weight, the plants were dried in oven at 60 C to constant weight and then the average dry weight was estimated like fresh weight.

4. Days to 50 percent flowering :

The 50 percent flowering days were counted in each plot in plants from there places in 1 m length and than the average of these was recorded from each plot. 50 percent maturity was also recorded from these plats from three places in the same days.

5. Days to 50 percent maturity:

The observations on 50 percent maturity were also recorded per plot in each plot of all the four varieties.

(B) Post harvest study of yield attributes and yield:

Prior to harvest of net plots, five tagged plants were harvested for post-harvest studies. These were brought to the laboratory for further detailed studies of following parameters.

1. Number of primary, secondary and tertiary branches/plant:

Number of primary, secondary and tertiary branches/plant was counted carefully from each tagged plant of each plot and then average was estimated from this for all the above-mentioned parameters.

2. Number and weight of capsules/plant:

Number of capsules was counted from each of the five sample-plant/plot and weight of capsules obtained from each plot was taken and then the average weight of capsule/plant was recorded.

3. Number of seeds/capsules and weight of seed/capsule:

Average number of seeds/capsule was calculated after the seed of 25 capsule from the tagged plants of each plot were counted. The mean number of seeds of twenty five capsules was calculated to show the number of seeds/capsules.

4. Seed yield/plant (g):

For this parameter, weight of seeds of five randomly selected plants from each plot was recorded and their average seed yield/plant was calculated.

5. Weight of total produce:

After harvesting and drying of the material from each net plot, the bundles of plants were weighted individually. This was recorded in kilograms per net plot. Afterwards the net plot yield was converted in quintals per hectare (q/ha). Then the whole produce of each plot was carefully transported to the threshing yard of the farm.

6. Seed yield and stover yield (q/ha):

After threshing of each plot dry material, seed yield in kilogram/net plot was recorded. The total seed yield per plot thus obtained was converted to total seed yield per hectare on the basis of net-plot size yield obtained from each plot.

Straw yield for each net plot was calculated by subtracting the grain yield per plot from total produce weighed before threshing and then it was converted into yield q/ha.

7. Harvested index:

It is defined as the ratio of total economic seed yield to the total biological yield (seed + stover) and is expressed in percentage. It is calculated by following formula:

$$\text{H.I.} = \frac{\text{Grain yield}}{\text{Total produce}} \times 100$$

Qualitative studies:

1. Test weight:

Cleaned seed samples were randomly taken from each plot. Then 1000 filled seeds were counted from each plot separately and weighted carefully on a chemical balance in the laboratory of Soil Science. The weight thus obtained was recorded as test weight of seeds in gram.

2. Protein content of seeds:

Total nitrogen content was estimated by Kjeldeahl's flask method (Chapman and Pratt, 1961). Then crude protein in seed was calculated by multiplying nitrogen percent with the factor 6.35 as given below:

$0.0014 \times 100 \times 10 \times A = N$

where, (A) = Burate reading

Protein percent = per cent of nitrogen x 6.25

3. Percent oil content:

Estimation of oil in seed samples of linseed was done by extracting oil from the moisture free material with ether using Soxhlet extractor as per the methods given by Chapman and Pratt (1961).

Oil Yield q/ha:

Oil yield q/ha was also estimated by multiplying the percent oil content of each treatment with yield q/ha obtained in each treatment. This gives the oil yield q/ha from each treatment.

Economic Studies:

During the introduction and cultivation of a crop it is essential to find out whether it is suitable economically for the area. Similarly during an experiment, it is also necessary to find out which of the treatment is enhancing the net income per hectare and which of them reduce it due to high cost of cultivation. In order to find out this, total cost of cultivation (Rs/ha), gross income (Rs/ha), net income (Rs/ha) and economic optimum input were calculated according to the prevailing cost of input and market price of the produce.

Response analysis:

Depending upon the nature of response appropriate curves (linear and quadratic) are fitted to workout optimum input quantity.

1. Linear response:

The linear response indicates the constant rate of increase in the output with a unit increase in the input factor. This is sown by following equation:

$$Y = a + bx,$$

where,

$$b=[\Sigma XY - (\Sigma X)(\Sigma Y)/N]/[\Sigma X^2 - (\Sigma X)^2/N]$$

And,

Y= expected yield

a = yield at 0 level of X

b= regression coefficient of Y on X

X= Unit of input

N= Number of observations

2. Quadratic response:

Quadratic response measures the deviation from linearity with increase inputs. The generalized model of the quadratic response curve is shown by the following equation:

$$Y= a + bX + cX^2$$

For fitting the quadratic response curve the method of orthogonal polynomials (Fisher, 1925) was followed. According to this procedure the estimates of 'a', 'b' and 'c' were obtained.

Statistical analysis:

The data collected on various parameters was analyzed separately according to analysis of variance technique (Panse and Sukhatme, 1978) for judging the effect of different treatments on crop plant, growth characters; yield and quality of linseed. Critical difference was calculated only for those characters, which were found significantly at one per cent or five per cent level of significance. The skeleton of analysis of variance of the design is presented in table-9.

Table-9: Skeleton of analysis of variance for split plot experiment (a split factorial arrangement).

Sources of variation	d.f.	S.S	M.S.S.	'F' value		
				Calculated	Tab.	
					5%	1%
Replication	2	SSR	MSR	MSR/MSEa		
Dates of sowing (D)	2	SSD	MSD	MSD/MSEa		
Error (a)	4	SSEa	MSEa			
Varieties (V)	3	SSV	MSV	MSV/MSEb		
No. of irrigation (I)	2	SSI	MSI	MSI/MSEb		
DxV	6	SS(DxV)	MS(DxV)	MS(DxV)/MSEb		
DxI	4	SS(DxI)	MS(DxI)	MS(DxI)/MSEb		
VxI	6	SS(VxI)	MS(VxI)	MS(VxI)/MSEb		
DxVxI	12	SS(DxVxI)	MS(DxVxI)	MS(DxVxI)/MSEb		
Error (b)	66	SSEb	MSEb			

where,

SSR = Sum of squares due to replication

SSD = Sum of squares due to dates of sowing

SSEa = Sum of squares due to error(a)

SSV	=	Sum of squares due to varieties			
SS(DxV)	=	Sum of squares due to interaction DxV			
SSI	=	Sum of squares due to irrigation levels			
SS(DxI)	=	Sum of squares due to interaction DxI			
SS(VxI)	=	Sum of squares due to interaction VxI			
SS(DxVxI)	=	Sum of squares due to interaction DxVxI			
SSEb	=	Sum of squares due to error(b)			
MSR	=	SSR/2	MSD	=	SSD/2
MSEa	=	SSEa/4	MSV	=	SSV/3
MS(DxV)	=	SS(DxV)/6	MSI	=	SSI/2
MS(DxI)	=	SS(DxI)/4	MS(VxI)	=	SS(VxI)/6
MS(DxVxI)	=	SS(DxVxI)/12	MSEb	=	SSEb/66

Calculation of S.E.(m) and C.D. (at 5%)

1. **S.E.(m) and C.D. for dates of sowing**

   S.E.(m)± = $\sqrt{MSEa/36}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 4 d.f.

2. **S.E.(m) and C.D. for varieties**

   S.E.(m)± = $\sqrt{MSEb/27}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 66 d.f.

3. **S.E.(m) and C.D. for irrigation levels**

   S.E.(m)± = $\sqrt{MSEb/36}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 66 d.f.

4. **S.E.(m) and C.D. for DxV**

   S.E.(m)± = $\sqrt{MSEb/9}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 66 d.f.

5. **S.E.(m) and C.D. for DxI**

   S.E.(m)± = $\sqrt{MSEb/12}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 66 d.f.

6. **S.E.(m) and C.D. for VxI**

   S.E.(m)± = $\sqrt{MSEb/9}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 66 d.f.

7. **S.E.(m) and C.D. for DxVxI**

   S.E.(m)± = $\sqrt{MSEb/3}$

   C.D.(at 5%) = S.E.(m) x $\sqrt{2}$ x t (5%) at 66 d.f.

Graphical representation of results:

The progressive growth data of stand, height, dry matter and all other attributes involving time factor or depicted by curves. Yield data, quality aspects of grain and level of irrigation are shown by histograms.

EXPERIMENTAL FINDINGS

CHAPTER-IV

EXPERIMENTAL FINDINGS

The results of the present investigation "Studies on the effect of different dates of sowing, varieties and number of irrigations on yield attributes, yield and quality of linseed (*Linum usitatisimum* L.) under Bundelkhand conditions of U.P." had been presented in foregoing pages of this chapter under the appropriate heads of the study. The interpretations are based on the analysis of variance and critical difference between the means at 5% level of significance. The variations in the response with respect to certain parameters have been illustrated with suitable diagrams wherever necessary for the convenience of understanding.

Plant population:

Plant population of the crop as affected by date of sowing, varieties and number of irrigation is given in table-10 and appendix-1.

Plant population due to date of sowing was not effected due to date of sowing as sown in the above table. However higher plant population was noticed in D_2 in 1^{st} year in D_1 in 2^{nd} year while on the mean of two years it was higher in D_1 (10 October sowing).

The plant population per plant was also not affected significantly among the varieties. However, V_2 (Neelum) and V_4 (Laxmi 27) was higher in 1^{st} year, in the 2^{nd} year and mean of 2 years V_2 had higher plant population than other varieties.

As regards irrigation levels, I_2 level of irrigation (2 irrigation at 30 and 60 DAS) regarded the higher plant population in 1st and mean of 2 years also.

Table-10: Effect of different treatments on the plant population per plot.

Treatment	1998	1999	Mean
Date of Sowing			
D_1	326.19	306.28	316.23
D_2	328.32	305.87	317.09
D_3	326.25	305.69	315.97
S.E.m±	0.82	0.76	0.56
C.D. (at 5%)	NS	NS	NS
Variety			
V_1	326.66	305.37	316.51
V_2	327.96	307.02	317.49
V_3	326.71	306.21	316.45
V_4	327.53	305.13	316.48
S.E.m±	1.69	0.71	1.30
C.D. (at 5%)	NS	NS	NS
No. of irrigation			
I_1	326.80	305.28	316.54
I_2	327.78	305.91	316.89
I_3	327.08	306.09	316.58
S.E.m±	1.46	0.61	1.12
C.D. (at 5%)	NS	NS	NS

Observing the field plots ~~for~~ before flowering

Fresh weight of plant at 30, 60, 90 DAS and at harvest:

Fresh weight of the plant at 30, 60, 90 DAS and at harvest as affected by dates of sowing, varieties and number of irrigation is given in table 11(a) to 11(e), appendix 2 to 5 and depicted in figure 4 to 6.

i) Fresh weight of plant at 30 and 60 DAS:

It is evident from table-11(a) that dates of sowing had not affected the fresh weight of plants 30 days after sowing in 1st year, 2nd year and in the pooled data of 2 years. However, the highest fresh weight was in D_2 (sowing on 25th October) in both the years and in the pooled data.

As regards the fresh weight of plant 60 days after sowing is concerned it was recorded significantly higher when the crop was sown on 25th October followed by 10th October sowing and 10th November sowing.

In case of varieties the fresh weight of plant was recorded significantly higher by V_2 (Neelum) than V_4 (Laxmi-27), followed by V_1 (Shubhra) and V_3 (Sweta) in both the years in both the times of 30 days and 60 days after sowing and in pooled data of 30 days and 60 days of sowing.

As regards irrigation level I_2 level (applied 30 and 60 days after sowing) recorded the maximum fresh weight of plant followed by I_3 level of irrigation (irrigation at 30, 60 & 90 days after sowing) over I_1 (irrigated 30 DAS). But these were not significant in 1st year and pooled data recorded 30 DAS. In case of data recorded 60 days after sowing it was observed that the fresh weight was

Showing $D_2V_3I_1$ treatment effect on linseed crop plants

Showing $D_2V_2I_1$ treatment effect on linseed crop plants

Showing $D_2V_2I_2$ treatment effect on linseed crop plants

significantly higher in I_2 than all other numbers of irrigation in both the years and in the pooled data.

Table-11(a): Effect of different treatments on fresh weight of plants at 30 & 60 DAS.

Treatment	Fresh weight (g) 30 DAS			Fresh weight (g) 60 DAS		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	4.93	4.85	4.89	8.89	8.61	8.75
D_2	5.04	5.04	5.04	10.23	9.78	10.01
D_3	4.78	4.57	4.68	8.68	8.33	8.50
S.E.m±	0.14	0.14	0.11	0.19	0.22	0.14
C.D. (at 5%)	NS	NS	NS	0.73	0.85	0.46
Variety						
V_1	5.05	4.85	4.95	8.53	8.58	8.55
V_2	5.32	5.28	5.30	10.87	10.42	10.64
V_3	5.28	5.04	5.16	9.57	9.14	9.35
V_4	4.01	4.10	4.05	8.09	7.49	7.79
S.E.m±	0.23	0.15	0.14	0.26	0.30	0.20
C.D. (at 5%)	0.66	0.43	0.39	0.75	0.84	0.56
No. of irrigation						
I_1	4.85	4.61	4.73	8.87	8.29	8.58
I_2	5.04	5.09	5.06	10.02	9.51	9.76
I_3	4.87	4.76	4.81	8.92	8.93	8.92
S.E.m±	0.20	0.13	0.12	0.23	0.26	0.17
C.D. (at 5%)	NS	0.37	NS	0.65	0.73	0.48

ii) Fresh weight of plant at 90 DAS and at harvest:

Fresh weight of the plant as affected by different treatments 90 days after sowing and at the time of harvesting is given in table-11(b), which is indicated that D_2 date of sowing recorded significantly higher fresh weight of plant at 90 DAS than D_1 and D_3 date of sowing in the year 1998. Even D_1 was found significantly superior in fresh weight than D_3. Similar trend was also found in date of sowing in second year and in the pooled data at 90 days after sowing and at harvest of the crop.

In case of varieties, significantly higher fresh weight was recorded in following order of significance Neelum followed by Sweta followed by Shubhra and then Laxmi-27 in both the years as well as in the pooled data of both years. From table-11(b) it is also clear further that I_2 level of irrigation recorded significantly maximum fresh weight of plant followed by I_3. Both I_2 and I_3 levels of irrigation were significantly superior to I_1 in both the years and in the pooled data recorded 90 days after sowing and at harvest.

The first order interaction between dates of sowing and varieties with regards to fresh weight of plant at 90 DAS was found to be significant (table-11(c)), which revealed that variety V_2 (Neelum) gave significantly higher weight/ plant than other varieties sown at any dates in the first year, second year and in the pooled data of both years. However, variety V_4 (Laxmi-27) produced significantly lower fresh weight/plant than other varieties (except D_1V_1) sown at any dates in the first year, second year and in the pooled data of both years. The maximum

fresh weight of 33.23, 32.09 and 32.66 g/plant was secured from D_2V_2 (25 October sowing date and variety Neelum) while minimum fresh weight of 16.22, 15.30 and 16.01 g/plant was obtained from D_3V_4 (10 November sowing date and variety Laxmi-27) in the first year, second year and in the pooled data of both years, respectively.

All the other interaction DxI, VxI and DxVxI effects on fresh weight of plant at 90 DAS were not found upto the significant level.

Interaction between dates of sowing and varieties with regards to fresh weight of plant at harvest was found to be significant (table-11(d)), which indicated that variety V_2 (Neelum) significantly enhanced the fresh weight/plant as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest fresh weight/plant which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum fresh weight of 90.83, 87.86 and 89.35 g/plant was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum fresh weight of 46.27, 41.61 and 43.44 g/plant was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively.

All the other interaction DxI, VxI and DxVxI effects on fresh weight of plant at harvest were not found upto the significant level.

Table-11(b): Effect of different treatments on fresh weight of plants 90 days after sowing and at harvest.

Treatment	Fresh weight of plant (g) 90 DAS			Fresh weight of plant (g) at Harvesting		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	23.28	22.38	22.83	65.72	63.99	64.85
D_2	26.31	25.41	25.86	74.24	71.82	73.03
D_3	21.23	20.08	20.65	54.67	53.74	54.20
S.E.m±	0.22	0.25	0.17	0.75	0.76	0.54
C.D. (at 5%)	0.56	1.00	0.55	2.96	3.01	1.76
Variety						
V_1	21.38	20.73	21.05	51.16	48.02	49.59
V_2	29.54	28.32	28.93	80.20	78.02	79.11
V_3	24.68	23.66	24.17	61.44	58.93	60.18
V_4	18.83	17.78	18.30	69.38	67.76	68.57
S.E.m±	0.31	0.33	0.22	0.69	0.75	0.51
C.D. (at 5%)	0.86	0.92	0.62	1.94	2.13	1.43
No. of irrigation						
I_1	22.00	21.02	21.51	61.93	58.89	60.41
I_2	25.49	24.36	24.92	70.32	68.66	69.49
I_3	23.33	22.49	22.91	64.38	62.01	63.19
S.E.m±	0.26	0.28	0.19	0.59	0.65	0.44
C.D. (at 5%)	0.75	0.80	0.53	1.68	1.84	1.23

Table-11(c): Interaction effect of DxV on fresh weight of plant at 90 DAS.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	20.32	29.38	24.39	19.04
D_2	23.63	33.23	27.66	20.72
D_3	20.19	26.00	21.99	16.72
2nd Year (1999)				
D_1	19.29	28.39	23.39	18.44
D_2	22.98	32.09	26.98	19.61
D_3	19.93	24.47	20.62	15.30
Pooled				
D_1	19.81	28.89	23.89	18.74
D_2	23.30	32.66	27.32	20.17
D_3	20.06	25.23	21.30	16.01

	S.E.m±	C.D. at 5%
1st Year (1998)	0.53	1.50
2nd Year (1999)	0.57	1.60
Pooled	0.39	1.09

Table-11(d): Interaction effect of DxV on fresh weight of plant at harvest.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	48.39	82.06	59.53	72.90
D_2	58.83	90.83	72.11	75.19
D_3	46.27	67.70	52.67	60.06
2nd Year (1999)				
D_1	47.11	80.06	58.24	70.54
D_2	55.32	87.86	68.78	75.30
D_3	41.61	66.14	49.77	57.45
Pooled				
D_1	47.75	81.06	58.88	71.72
D_2	57.08	89.35	70.45	75.25
D_3	43.94	66.92	51.22	58.75

	S.E.m±	C.D. at 5%
1st Year (1998)	1.19	3.36
2nd Year (1999)	1.31	3.69
Pooled	0.88	2.48

In the first year 1998, interaction effect of varieties and irrigation levels on fresh weight of plant at harvest was found to be significant (table-11(e)), which revealed that variety V_2 (Neelum) gave significantly higher fresh weight/plant than other varieties at all irrigation levels. However, variety V_1 (Shubhra) gave

FIG. 4: EFFECT OF DATES OF SOWING ON FRESH WEIGHT/PLANT

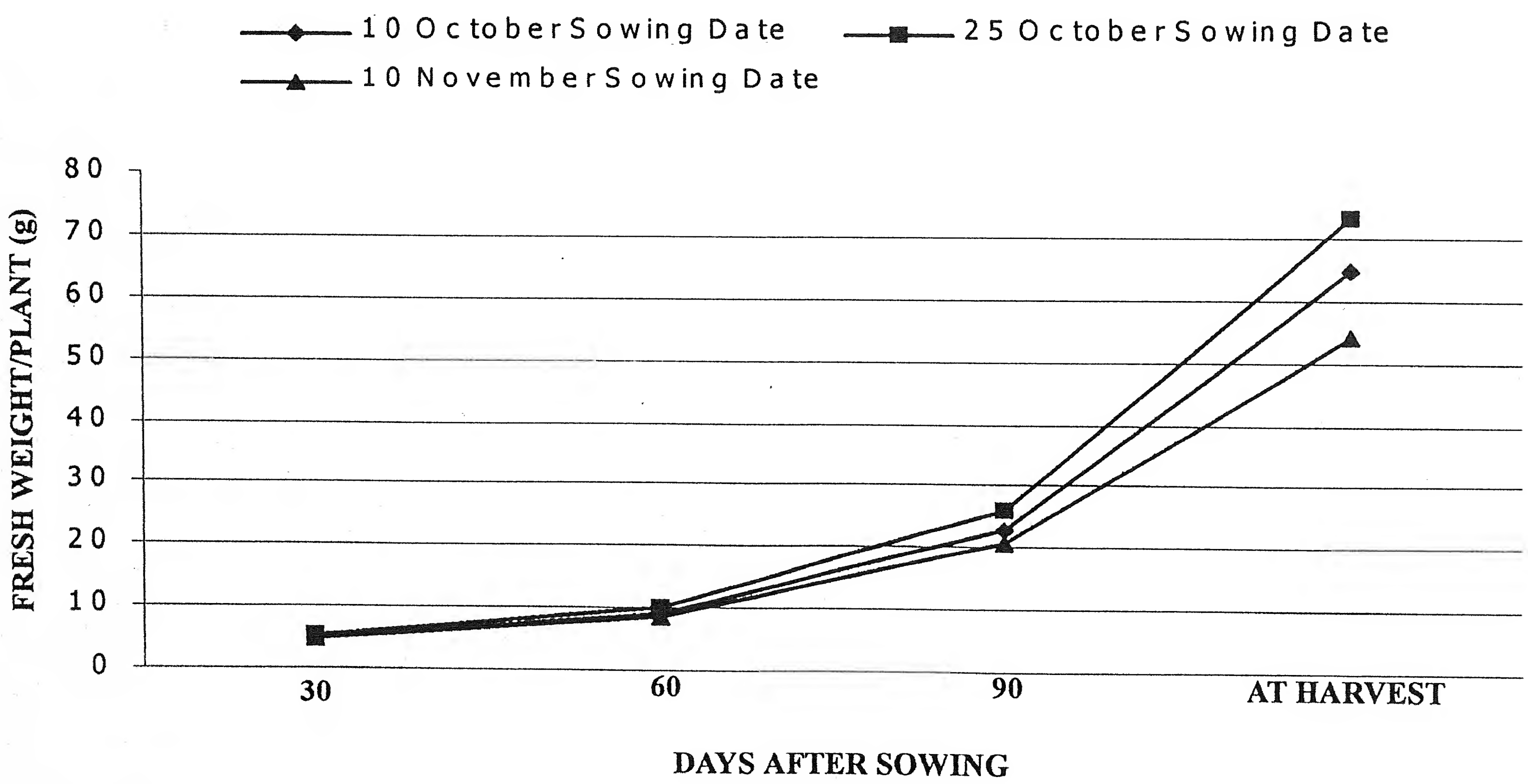


FIG. 5: EFFECT OF VARIETIES ON FRESH WEIGHT/PLANT

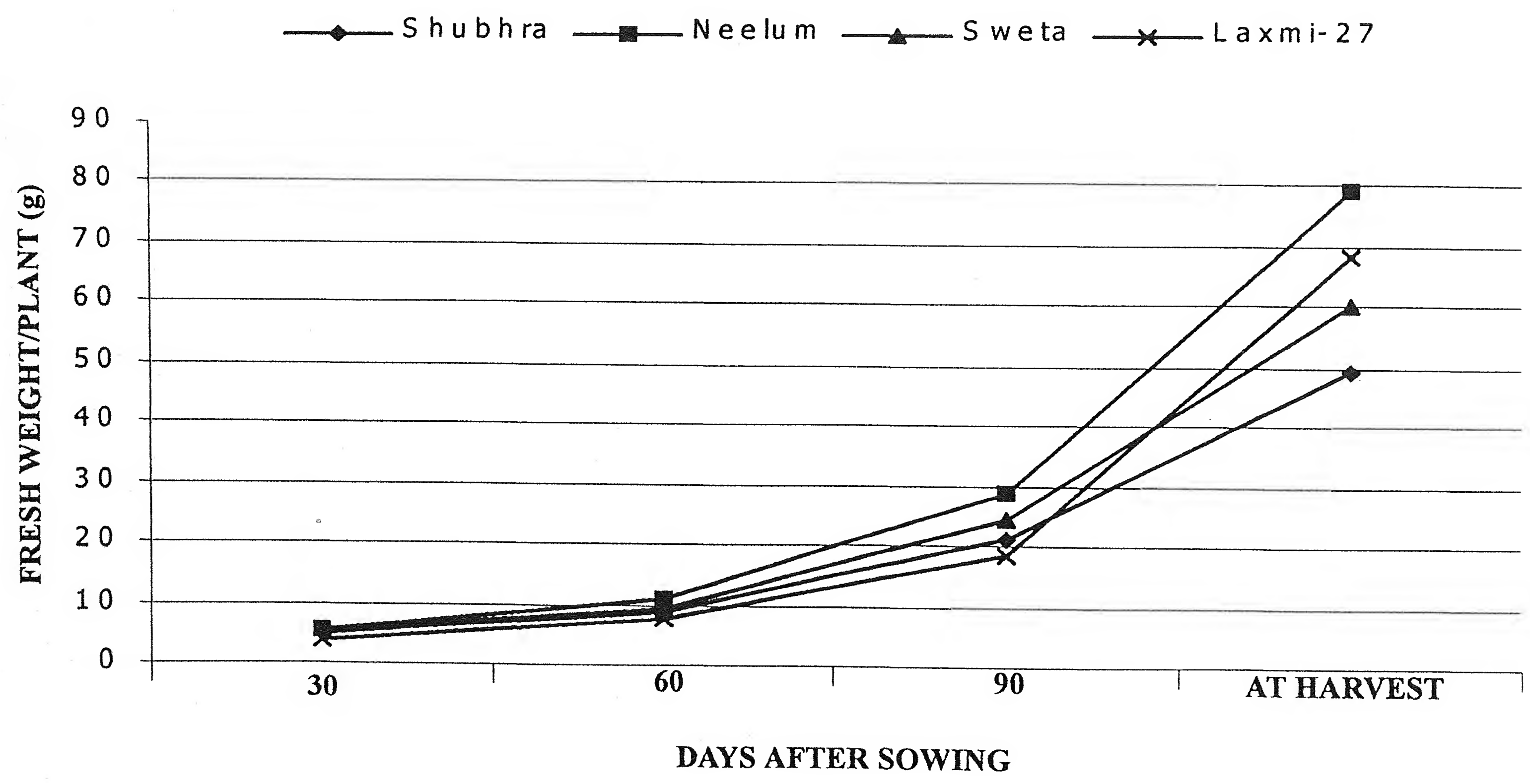
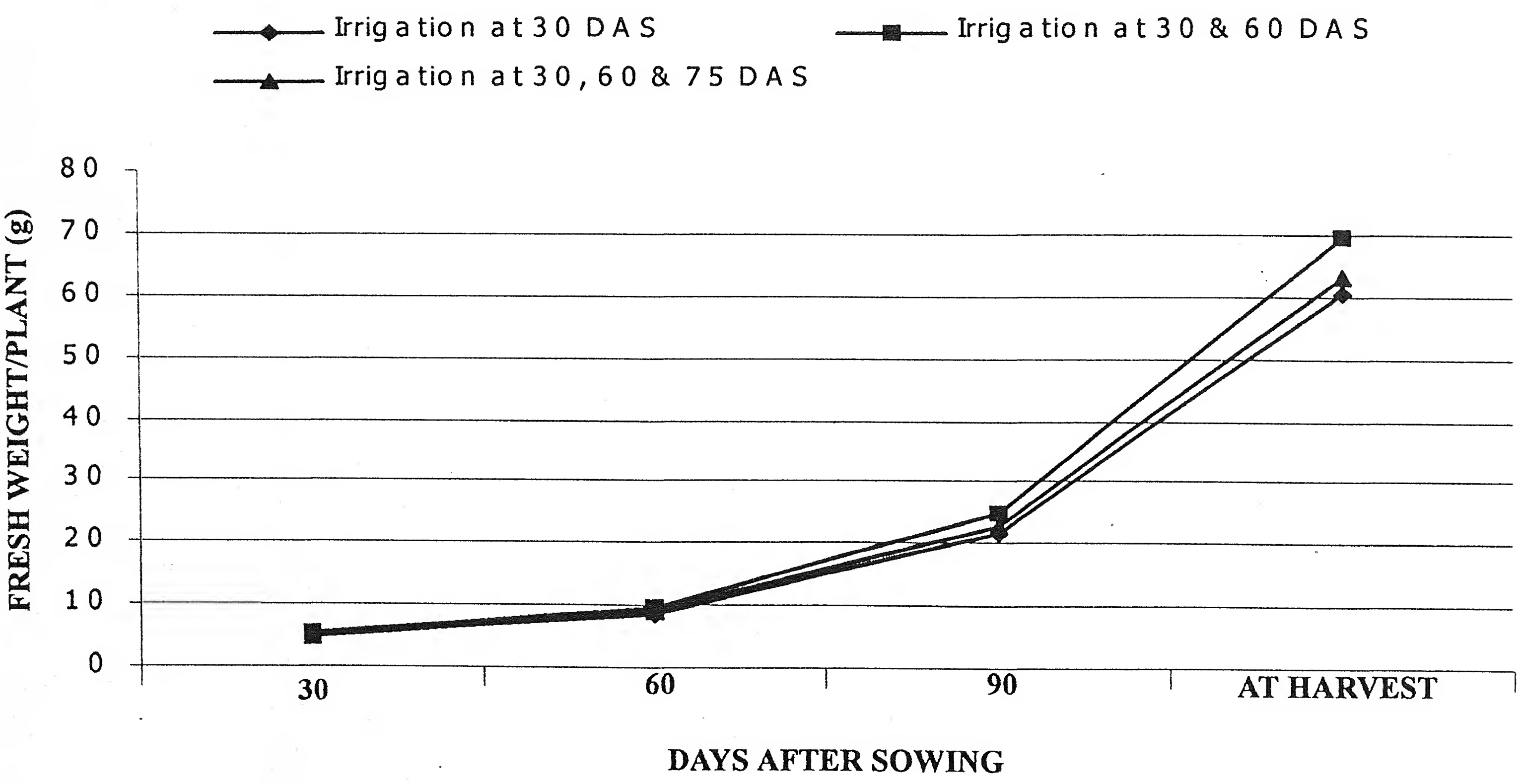


FIG. 6: EFFECT OF IRRIGATION LEVELS ON FRESH WEIGHT/PLANT



significantly lower fresh weight/plant than other varieties at all irrigation levels. The highest fresh weight (83.64 g/plant) was recorded in V_2I_2 (variety Neelum and irrigation at 30 and 60 DAS) and lowest fresh weight (44.13 g/plant) in V_1I_1 (variety Shubhra and irrigation at 30 DAS).

The interaction effects DxI and DxVxI were not found upto the significant level.

Table-11(e): Interaction effect of VxI on fresh weight of plant at harvest.

(Year-1998)

Varieties	**Irrigation levels**		
	I_1	I_2	I_3
V_1	44.13	52.66	47.27
V_2	74.54	83.64	75.88
V_3	54.33	64.49	57.97
V_4	62.54	73.84	66.91
		VxI	
S.E.m±		1.19	
C.D. at 5%		3.36	

Dry weight of plant at 30, 60, 90 DAS and at harvest:

Dry weight of plant at 30, 60, 90 DAS and at harvest as affected by dates of sowing, varieties and irrigation levels is given in table 12(a) to 12(d), appendix 6 to 9 and depicted in figure 7 to 9.

i) Dry weight/plant at 30 & 60 DAS:

It is evident from table-12(a) that maximum dry weight at 30 DAS was recorded in D_2 (25 October) date of sowing significantly higher then D_3, but D_1

and D_2 are at par in dry weight of plant. Though D_1 produced higher dry weight of plant than D_3 (10 November sowing) but value is not significantly higher. Similarly trend with respect to dry weight of plant was found in both the years and in the pooled data. Almost similar trend was noticed in dry weight of plant 60 days after sowing.

As regards the dry weight of plants recorded in different varieties, V_2 (Neelum) had significantly higher dry weight of plant than all other varieties, followed by Sweta, Shubhra and Laxmi-27 which recorded significantly lowest dry weight of plants in both the years and in the pooled data at 30 days after sowing. Similar trend of dry weight of plant was also noticed in 60 DAS.

On perusal of table-12(a) further, it is clear that I_2 irrigation level recorded significantly higher dry weight of plant than other levels of irrigation. I_3 level also recorded significantly higher dry weight than I_1 level of irrigation in both the years and in pooled data 30 days after sowing. Similar trend was also recorded in dry weight of plant recorded 60 days after sowing in different levels of irrigation in both the years and in pooled data.

Interaction effect of dates of sowing and varieties on dry weight of plant at 30 DAS was found to be significant (table-12(b)), which revealed that variety V_2 (Neelum) gave significantly higher dry weight per plant than other varieties sown at any dates accept D_3V_3 (variety Sweta sown 10 November) in the first year as well as in the pooled data of both years, D_1V_3 & D_3V_3 (variety Sweta sown on 10 October and 10 November).

All other 1st and 2nd order interaction effects (DxI, VxI and DxVxI) on dry weight at 30 DAS were not found upto the significant level.

Table-12(a): Effect of different treatments on dry weight of plants 30 DAS and 60 days after sowing.

Treatment	Dry weight (g) 30 DAS			Dry weight (g) 60 DAS		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	0.57	0.55	0.56	2.89	2.71	2.80
D_2	0.72	0.69	0.71	3.28	2.99	3.13
D_3	0.51	0.48	0.50	2.53	2.34	2.43
S.E.m±	0.05	0.04	0.03	0.07	0.07	0.05
C.D. (at 5%)	0.20	0.15	0.10	0.28	0.28	0.16
Variety						
V_1	0.58	0.55	0.57	2.78	2.50	2.64
V_2	0.65	0.63	0.64	3.26	3.08	3.17
V_3	0.62	0.59	0.61	3.08	2.76	2.92
V_4	0.55	0.52	0.54	2.47	2.38	2.42
S.E.m±	0.006	0.006	0.004	0.14	0.13	0.09
C.D. (at 5%)	0.017	0.017	0.011	0.38	0.37	0.25
No. of irrigation						
I_1	0.57	0.54	0.55	2.64	2.47	2.55
I_2	0.63	0.60	0.62	3.15	2.99	3.07
I_3	0.59	0.57	0.58	2.90	2.58	2.74
S.E.m±	0.005	0.005	0.003	0.12	0.11	0.08
C.D. (at 5%)	0.015	0.015	0.008	0.33	0.32	0.22

Table-12(b): Interaction effect of DxV on dry weight of plant at 30 DAS.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	0.56	0.62	0.59	0.50
D_2	0.70	0.79	0.72	0.65
D_3	0.47	0.53	0.54	0.48
2nd Year (1999)				
D_1	0.54	0.59	0.57	0.49
D_2	0.67	0.78	0.69	0.62
D_3	0.44	0.51	0.50	0.46
Pooled				
D_1	0.55	0.60	0.58	0.49
D_2	0.69	0.78	0.71	0.64
D_3	0.46	0.52	0.52	0.47

	S.E.m±	C.D. at 5%
1st Year (1998)	0.010	0.030
2nd Year (1999)	0.011	0.031
Pooled	0.008	0.021

ii) **Dry weight/plant at 90 DAS and at harvest:**

It can be inferred from table-12(c) that in first year D_2 date of sowing produced significantly higher dry weight then D_3 and D_1, while D_3 & D_1 are at par. In 2^{nd} year while in 2^{nd} year D_2 was found significant superior to D_3 only while D_1 and D_2 are at par. In the pooled data of two years D_2 (25 October) sowing date had significantly higher dry weight than D_1 (10 October sowing) and D_3 (10 November sowing) and D_1 & D_2 are at par.

Dry weight at harvest was found significantly superior than D_3 and D_1, while D_1 also had significantly higher dry weight than D_3. Similar trend was also found in 2^{nd} year and in the pooled data of two years.

Neelum produced significantly higher dry weight of plant at 90 days after sowing, followed by Sweta than Shubhra and Laxmi-27 which are at par with respect to production of dry weight. Similar results were also found in 2^{nd} year and in the pooled data of two years.

I_2 that is irrigation at 30 and 60 days after sowing recorded significantly higher dry weight of plants than 12 and 13 in 1^{st} year while in second year I_2 has recorded higher dry weight then I_1 & I_3 which were at par. However, in the pooled data the trend was of 1^{st} year.

As regards the dry weight at harvest, Neelum produced significantly higher dry weight then Sweta, Shubhra and Laxmi-27 varieties. Further it is also interesting to note that Laxmi-27 produced significantly higher dry weight than

Sweta, which is also significantly superior in weight than Shubhra. Similar trend was also recorded in 2nd year and pooled data of two year.

In case of irrigation levels the dry weight at harvest was found significantly higher by 12 irrigation (viz. 30 and 60 days after sowing) than I_3 (irrigation at 20, 60 and 90 after sowing which was found significantly better with respect to dry weight than I_1 (irrigation at 30 DAS).

Interaction between dates of sowing and varieties with regards to dry weight of plant at harvest was found to be significant (table-12(d)), which indicated that variety V_2 (Neelum) significantly enhanced the dry weight/plant as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Sweta) produced lowest dry weight/plant which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum dry weight of 89.04, 86.62 and 87.83 g/plant was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum dry weight of 41.52, 34.11 and 37.82 g/plant was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively.

All the other interaction DxI, VxI and DxVxI effects on dry weight of plant at harvest were not found upto the significant level.

Table-12(c): **Effect of different treatments on dry weight of plant 90 days after sowing and at harvest.**

Treatment	Dry weight (g) 90 DAS			Dry weight at harvest (g)		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	9.52	8.99	9.25	63.69	61.53	62.61
D_2	11.07	10.43	10.75	72.73	69.52	71.12
D_3	8.53	8.03	8.28	54.28	48.97	51.62
S.E.m±	0.38	0.44	0.29	0.64	0.61	0.44
C.D. (at 5%)	1.51	1.74	0.95	2.52	2.39	1.43
Variety						
V_1	9.02	8.48	8.75	48.07	43.98	46.02
V_2	11.16	10.53	10.84	78.36	76.01	77.18
V_3	10.30	9.69	9.99	59.53	56.11	57.82
V_4	8.33	7.93	8.13	68.28	63.94	66.11
S.E.m±	0.27	0.20	0.17	0.63	0.74	0.49
C.D. (at 5%)	0.75	0.57	0.48	1.79	2.08	1.37
No. of irrigation						
I_1	9.27	8.62	8.94	59.07	55.93	57.50
I_2	10.18	9.83	10.01	68.92	64.74	66.83
I_3	9.66	9.00	9.33	62.70	59.36	61.03
S.E.m±	0.23	0.17	0.15	0.55	0.64	0.42
C.D. (at 5%)	0.65	0.49	0.42	1.55	1.80	1.17

FIG. 7: EFFECT OF DATES OF SOWING ON DRY WEIGHT/PLANT

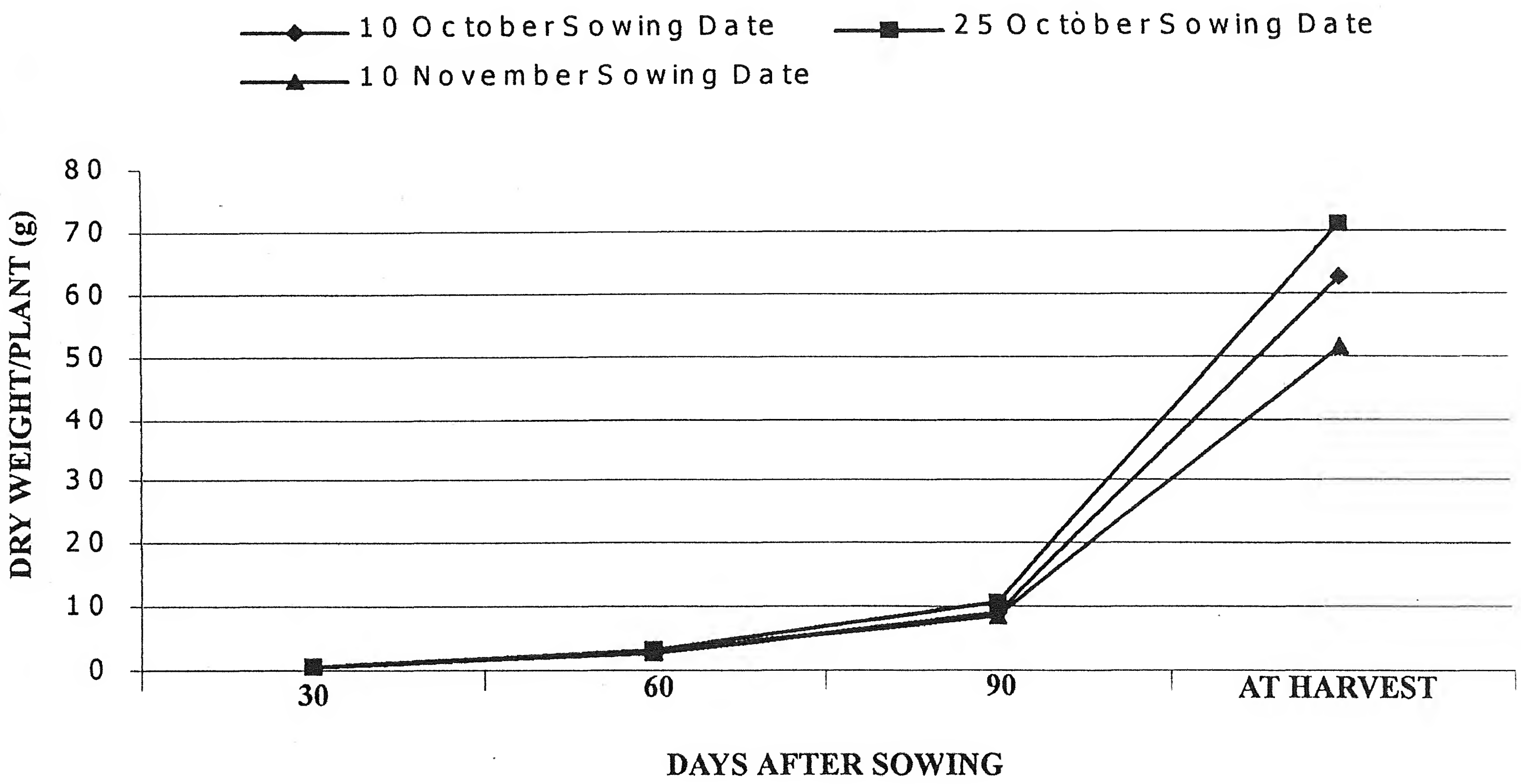


FIG. 8: EFFECT OF VARIETIES ON DRY WEIGHT/PLANT

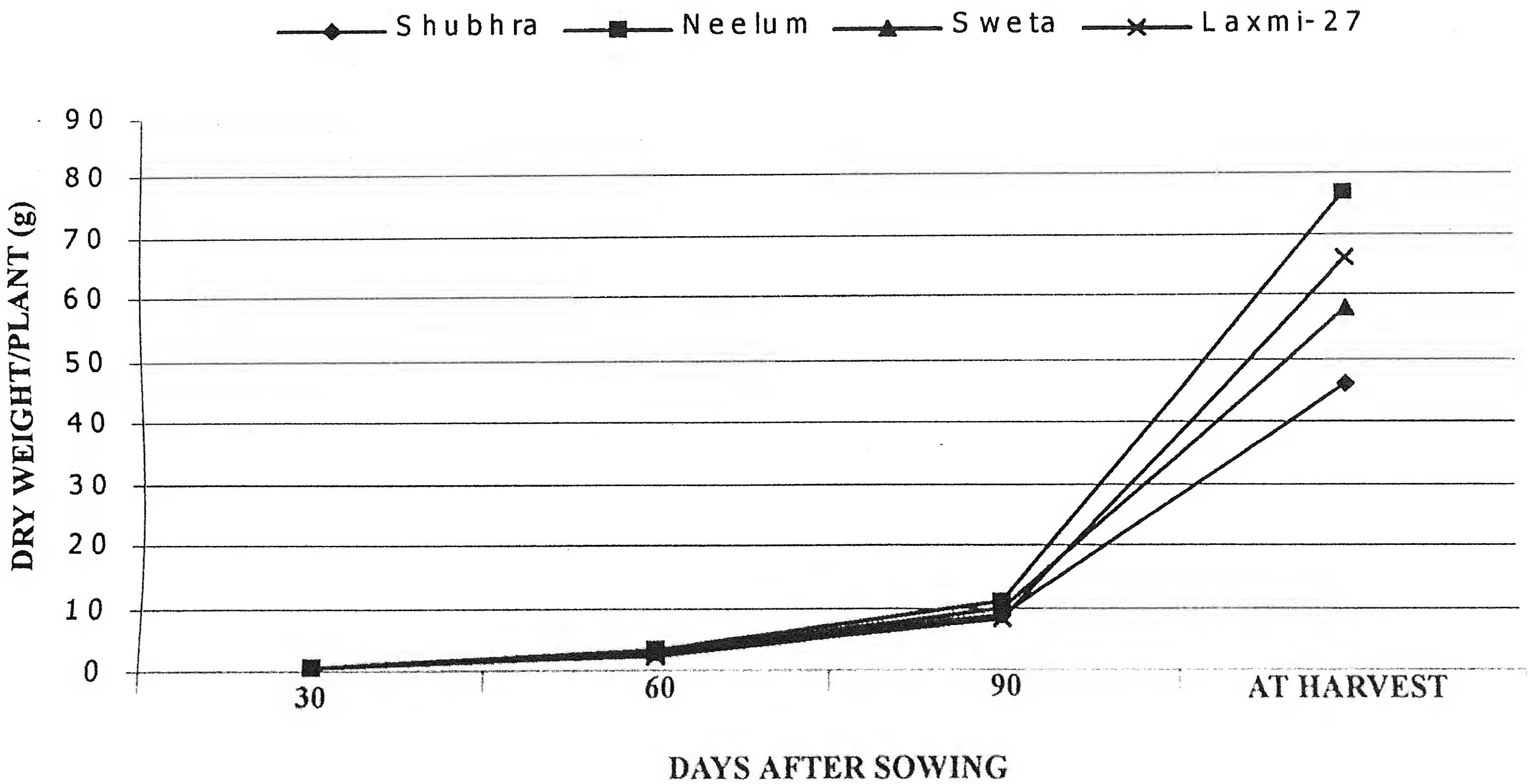


FIG. 9: EFFECT OF IRRIGATION LEVELS ON DRY WEIGHT/PLANT

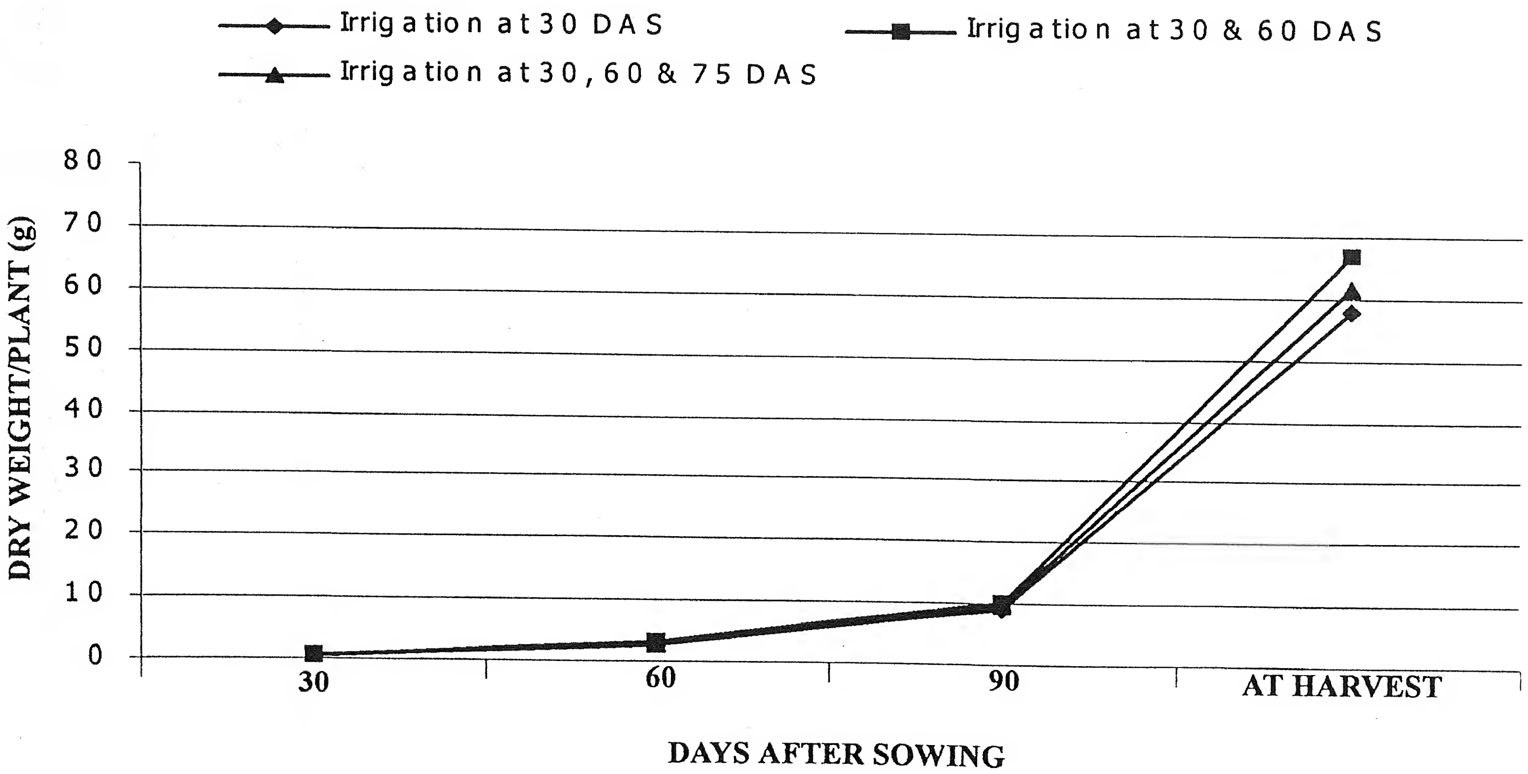


Table-12(d): Interaction effect of DxV on dry weight of plant at harvest.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
<u>1st Year (1998)</u>				
D_1	46.62	79.66	57.47	71.00
D_2	56.08	89.04	70.22	75.56
D_3	41.52	66.39	50.90	58.29
<u>2nd Year (1999)</u>				
D_1	45.11	78.43	54.77	67.82
D_2	52.72	86.62	66.66	72.10
D_3	34.11	62.96	46.90	51.90
<u>Pooled</u>				
D_1	45.86	79.04	56.12	69.41
D_2	54.40	87.83	68.44	73.83
D_3	37.82	64.68	48.90	55.10

	S.E.m±	C.D. at 5%
1st Year (1998)	1.10	3.10
2nd Year (1999)	1.28	3.61
Pooled	0.84	2.36

Days to 50% flowering:

Days to 50% flowering as affected by dates of sowing, varieties and irrigation levels is given in table 13(a) to 13(b), appendix 10 and depicted in figure 10.

Perusal of the data presented in table-13(a) indicated that days to 50% flowering significantly influenced by all the treatments. The maximum days to

50% flowering was recorded in D_1 (10 October sowing date) which was significantly higher than D_2 and D_3 in both the years as well as in pooled data. The difference between the effects of D_2 and D_3 was also found significant.

Table-13(a) further indicated that variety V_2 (Neelum) took significantly maximum days to 50% flowering as compared to other varieties in 1st year, 2nd year and in pooled data of both years. The second best variety was found V_1 (Shubhra) which was significantly superior to V_3 and V_4 in respect to taking maximum days in 50% flowering. However, the difference between the effects of varieties V_3 and V_4 on days to 50% flowering was not found upto the significant level.

The effect of irrigation level I_2 (irrigation at 30 and 60 DAS) on days to 50% flowering was found significantly higher than I_1 and I_3. The irrigation level I_3 (irrigation at 30, 60 and 75 DAS) was found significantly inferior than other irrigation levels in respect to taking maximum days to 50% flowering.

The interaction effect of dates of sowing and varieties on days to 50% flowering was found to be significant (table-13(b)), which revealed that significantly maximum days to 50% flowering was noticed in variety V_2 (Neelum) than other varieties sown at any dates in the 1st year, 2nd year and in pooled data of both years. The maximum days to 50% flowering (81.33, 76.56 and 78.94) was recorded in D_1V_2 (10 October sowing date and variety Neelum) treatment combination while minimum days to 50% flowering (52.33, 47.67 and 50.00) was recorded in D_3V_3 (10 November sowing date and variety Sweta)

Showing $D_2V_2I_2$ treatment effect at 50 percent flowering stage of crop

treatment combination in the 1st year, 2nd year and in pooled data of both years, respectively. Interaction effects DxI, VxI and DxVxI were not found upto the significant level.

Table-13(a): Effect of different treatments on days to 50% flowering.

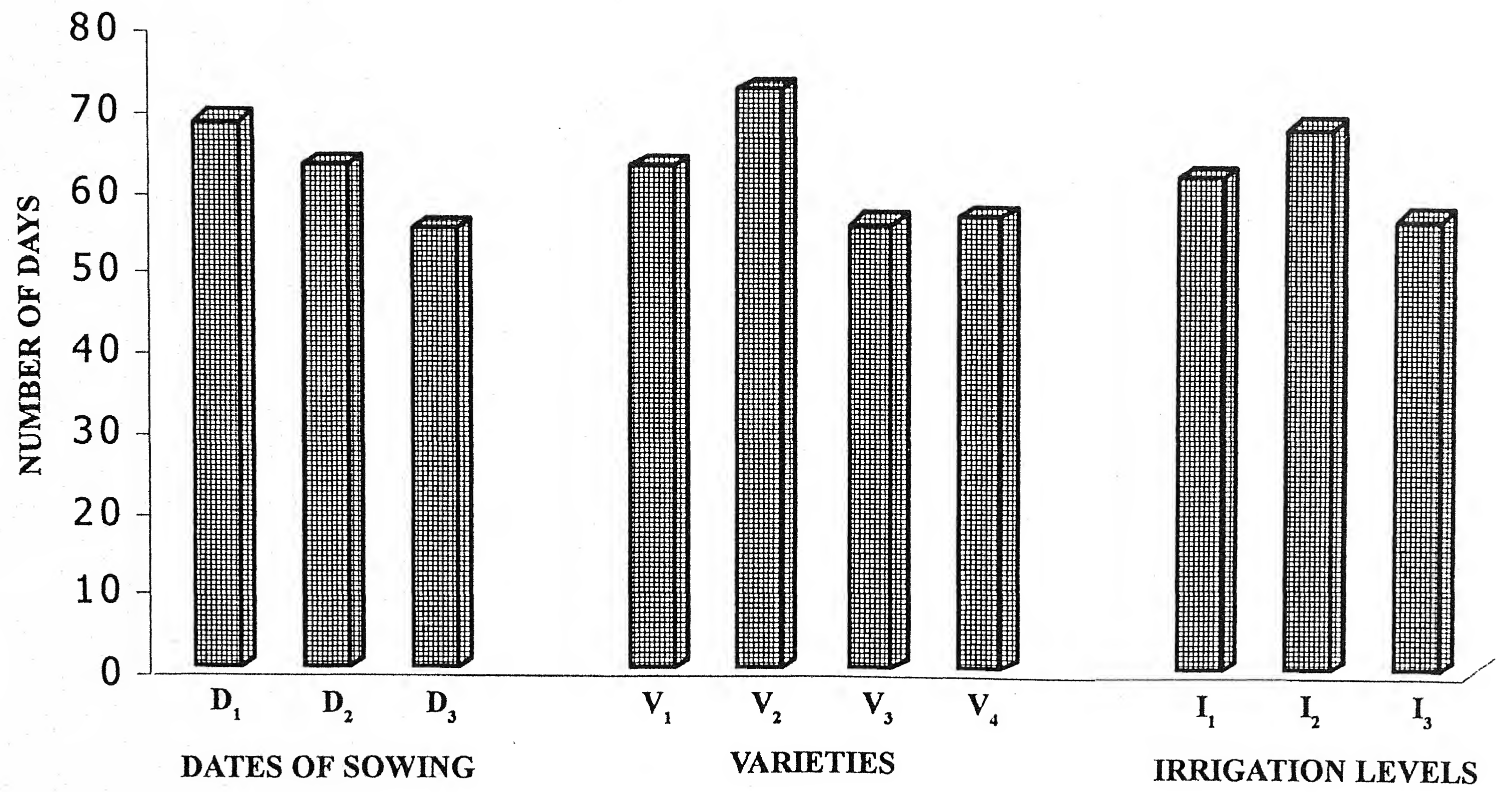
Treatment	Days to 50% flowering		
	1998	1999	Pooled
Date of Sowing			
D_1	69.42	66.22	67.82
D_2	64.00	61.00	62.50
D_3	56.58	52.92	54.75
S.E.m±	0.81	0.37	0.45
C.D. (at 5%)	3.19	1.44	1.45
Variety			
V_1	64.11	61.22	62.66
V_2	74.00	70.52	72.26
V_3	57.22	53.67	55.44
V_4	58.00	54.78	56.39
S.E.m±	0.59	0.49	0.38
C.D. (at 5%)	1.67	1.39	1.08
No. of irrigation			
I_1	63.42	59.64	61.53
I_2	69.00	65.75	67.38
I_3	57.58	54.75	56.16
S.E.m±	0.52	0.42	0.33
C.D. (at 5%)	1.45	1.20	0.93

Table-13(b): Interaction effect of DxV on day to 50% flowering.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
<u>1st Year (1998)</u>				
D_1	70.33	81.33	62.33	63.67
D_2	67.33	75.00	57.00	56.67
D_3	54.67	65.67	52.33	53.67
<u>2nd Year (1999)</u>				
D_1	68.33	76.56	59.33	60.67
D_2	63.67	73.00	54.00	53.33
D_3	51.67	62.00	47.67	50.33
<u>Pooled</u>				
D_1	69.33	78.94	60.83	62.12
D_2	65.50	74.00	55.50	55.00
D_3	53.17	63.83	50.00	52.00

	S.E.m±	C.D. at 5%
1st Year (1998)	1.03	2.90
2nd Year (1999)	0.85	2.40
Pooled	0.67	1.87

FIG. 10: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON DAYS TO 50% FLOWERING



Judging the full maturity of crop

Showing the inspection of maturity of crop in the field

Days to 50% maturity:

Days to 50% maturity as affected by dates of sowing, varieties and irrigation levels is given in table 14, appendix 11 and depicted in figure 11.

It is evident from table-14 that the dates of sowing affected the days to 50% maturity significantly. Date of sowing D_1 (10 October) recorded significantly higher days to 50% maturity than D_2 (25 October) and D_3 (10 November). The difference between the effects of D_2 and D_3 on days to 50% maturity was found significant. Similar trend is found in second year and in pooled data of both years.

In case of varieties, the days to 50% maturity was affected significantly due to varieties in the 1st year, 2nd year and in pooled data of both years. The variety V_2 took significantly higher days to 50% maturity than all other varieties. The second best variety was found V_1 or V_3 which was significantly superior to V_4 in respect of taking higher days to 50% maturity but both varieties (V_1 and V_3) were found at par.

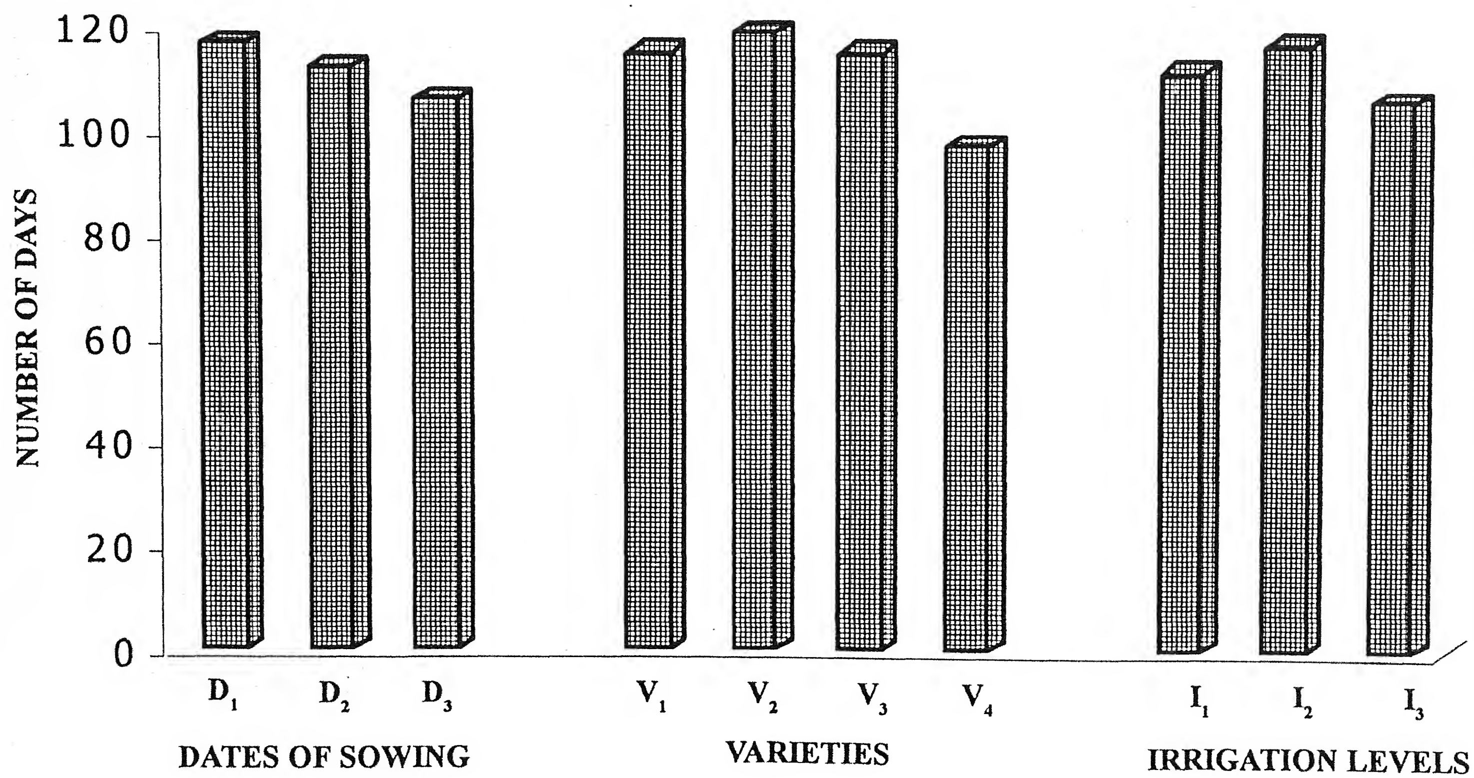
As regards to the effect of irrigation levels on days to 50% maturity in 1st year, 2nd year and pooled data of both years; Irrigation level I_2 took significantly higher days to 50% maturity than I_1 and I_3. Although the difference between the effect of I_1 and I_3 on days to 50% maturity was also found to be significant.

All the first and second order interactions were not found upto the significant level.

Table-14: Effect of different treatments on days to 50% maturity.

Treatment	Days to 50% maturity		
	1998	1999	Pooled
Date of Sowing			
D_1	118.08	115.33	116.70
D_2	113.50	110.64	112.07
D_3	107.83	104.47	106.15
S.E.m±	0.66	0.60	0.44
C.D. (at 5%)	2.58	2.35	1.45
Variety			
V_1	116.78	113.19	114.98
V_2	120.67	117.63	119.15
V_3	116.67	113.78	115.23
V_4	98.44	96.00	97.22
S.E.m±	0.83	0.76	0.56
C.D. (at 5%)	2.35	2.14	1.58
No. of irrigation			
I_1	113.08	110.33	111.70
I_2	118.58	115.53	117.06
I_3	107.75	104.58	106.16
S.E.m±	0.72	0.66	0.49
C.D. (at 5%)	2.03	1.85	1.37

FIG. 11: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON DAYS TO 50% MATURITY



Height of main shoot at 30, 60, 90 DAS and at harvest:

Height of main shoot at 30, 60, 90 DAS and at harvest as affected by date of sowing, varieties and irrigation levels is given in table 15(a) to 15(d), appendix 12 to 15 and figure 12 to 14.

i) Height of main shoot at 30 and 60 DAS:

It is evident from table-15(a) that the dates of sowing affected the height of main shoot significantly. Both D_1 (10 October) and D_2 (25 October) date of sowings recorded significantly higher height of main shoot than D_3 (10 November) sowing. However, both D_1 and D_2 were at par. Similar trend in data is found in 2^{nd} year and in the pooled data recorded 30 days after sowing. In case of data recorded 60 days after sowing, similar trend is noticed in the height of main shoot in both the years and in the pooled data of two years recorded at 60 DAS. Further from table-15(a) it is also clear that in first year V_2 and V_3 (Neelum and Sweta) are at par and produced significantly higher main shoot height than V_1 and V_4, which were at par. In 2^{nd} year the main shoot height was produced significantly in following order V_2 followed by V_3 and than V_1 and V_4 and these two were at par. In pooled data the trend at main shoot height was also significantly affected due to varieties in following order V_2, V_3, V_1 followed by V_4 (Laxmi-27). As regards the height of main shoot at 60 days after sowing due to varieties, the difference was noticed significant and the order of significance was V_2 (Neelum) followed by V_1 (Shubhra), then V_3 (Sweta) followed by V_4 (Laxmi-

27). Almost similar trend in the height of main shoot was observed in 2nd year and pooled data of two years.

In case of irrigation levels, the height of main shoot was affected significantly due to irrigation levels in both the years and in the polled data 30 days after sowing. Both in 1st year and 2nd year I_2 irrigation (applied 30 and 60 days after sowing) was significantly produced higher height of the main shoot than I_1 and I_3 which were at par. Similar trend is also found in 2nd year and polled data of two years in 30 DAS.

As regards the affect of irrigation level on main shoot height 60 DAS, in first year both I_1 and I_2 are at par and significantly superior to I_3. In 2nd year and in pooled data of two year I_2 and I_3 levels of irrigation are at par and significantly superior then I_1 (irrigation at 30 DAS).

Interaction effect of dates of sowing and varieties on height of main shoot at 30 DAS was found to be significant (table-15(b)), which revealed that the treatment combination D_1V_2 (10 October sowing date and variety Neelum) significantly enhanced the height of main shoot as compared to other treatment combinations (except D_2V_3 in the 1st year) in both years as well as in pooled data.

Interaction effect of dates of sowing and varieties on height of main shoot at 60 DAS was found to be significant (table-15(c)), which revealed that the treatment combination D_2V_2 (25 October sowing date and variety Neelum) significantly enhanced the height of main shoot as compared to other treatment combinations except D_1V_1, D_1V_2, D_1V_3 in the 1st year and D_2V_1 in 2nd year.

Recording the height of main shoot of plants

The other interaction effects (DxI, VxI and DxVxI) on height of main shoot at 30 and 60 DAS were not found upto the level of significance.

Table-15(a): Effect of different treatments on height of main shoot 30 and 60 days after sowing.

Treatment	Height of main shoot (cm) at 30 DAS			Height of main shoot (cm) at 60 DAS		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	17.85	16.38	17.11	50.19	48.97	49.58
D_2	17.54	16.53	17.04	49.82	48.80	49.31
D_3	14.82	14.11	14.46	46.78	46.13	46.46
S.E.m±	0.21	0.22	0.15	0.57	0.58	0.40
C.D. (at 5%)	0.82	0.86	0.49	2.24	2.26	1.30
Variety						
V_1	16.37	15.55	15.96	50.19	48.67	49.43
V_2	18.04	16.48	17.26	52.18	51.42	51.80
V_3	16.85	15.81	16.33	48.12	47.12	47.62
V_4	15.68	14.84	15.26	45.23	44.66	44.99
S.E.m±	0.19	0.33	0.19	0.67	0.57	0.44
C.D. (at 5%)	0.55	0.92	0.53	1.88	1.60	1.23
No. of irrigation						
I_1	16.64	15.07	15.85	48.99	47.06	48.02
I_2	17.18	16.52	16.85	50.11	49.11	49.61
I_3	16.39	15.42	15.91	47.68	47.74	47.71
S.E.m±	0.17	0.28	0.16	0.58	0.49	0.38
C.D. (at 5%)	0.48	0.79	0.45	1.63	1.38	1.06

Table-15(b): Interaction effect of DxV on height of main shoot at 30 DAS.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	16.65	20.83	17.56	16.35
D_2	17.33	18.06	18.11	16.64
D_3	15.12	15.22	14.88	14.06
2nd Year (1999)				
D_1	15.38	18.55	16.40	15.19
D_2	16.56	16.37	17.31	15.88
D_3	14.72	14.53	13.73	13.47
Pooled				
D_1	16.01	19.69	16.98	15.77
D_2	16.95	17.22	17.71	16.26
D_3	14.92	14.87	14.30	13.77

	S.E.m±	C.D. at 5%
1st Year (1998)	0.34	0.95
2nd Year (1999)	0.56	1.59
Pooled	0.33	0.92

Table-15(c): Interaction effect of DxV on height of main shoot at 60 DAS.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	51.78	52.38	52.15	44.45
D_2	52.09	54.92	46.17	46.10
D_3	46.69	49.22	46.05	45.16
2nd Year (1999)				
D_1	49.72	51.71	50.46	43.97
D_2	50.66	53.47	45.90	45.18
D_3	45.63	49.07	45.00	44.83
Pooled				
D_1	50.75	52.05	51.30	44.21
D_2	51.38	54.20	46.04	45.64
D_3	46.16	49.14	45.53	44.99

	S.E.m±	C.D. at 5%
1st Year (1998)	1.15	3.26
2nd Year (1999)	0.98	2.76
Pooled	0.76	2.12

ii) Height of main shoot at 90 DAS and at harvest:

The table-15(d) revealed that the dates of sowing affected the height of main shoot at 90 DAS significantly. Though D_1 and D_2 dates are at par but both produced significantly higher height of main shoot than D_3 (10 November sowing) in both the years and in the pooled data of 90 DAS. In case of height of main shoot at harvest, it can be seen that the maximum height of main shoot was found in D_2 (25 October sowing) followed by D_1 (10 October sowing) than D_3 (10

November sowing) but the difference among them is not significant in both the years and in the polled data of two years.

Height of main shoot in all four varieties was also found significantly different in both the years and in pooled data 90 days after sowing. Variety Neelum recorded significantly maximum height of main shoot than Sweta, Shubhra and Laxmi-27, while Sweta recorded significantly higher height than Shubhra which itself has significantly higher height than Laxmi-27 in first year. In 2nd year Neelum recorded significantly maximum height of main shoot than Shubhra and Sweta which were at par but both are significantly superior than Laxmi-27. Similar trend can be seen in pooled data at 90 DAS. Height at harvest of main shoot was significantly higher in V_2 then Sweta, Shubhra and Laxmi-27 varieties. Sweta was also found significant in main shoot height than Shubhra which is significant than Laxmi-27 in both the years and in the pooled data.

On considering the affect of irrigation on main shoot height at 90 DAS, it is revealed from the table-16 that in first year I_2 (irrigation at 30 and 60 DAS) recorded significantly higher height than I_1 and I_3 which are at par while in 2nd year I_2 is recorded significantly higher main shoot height than I_1, while I_2 and I_3 levels of irrigation were at par but had significantly lower main shoot height then I_2 level.

The main shoot height at harvest was found significantly higher in I_2 (irrigation at 30 & 60 DAS) than I_1 and I_3 levels, which are at par in both the years and in the pooled data of two years.

Table-15(d): Effect of different treatments on height of main shoot 90 DAS and at harvest.

Treatment	Height of main shoot (cm) at 90 DAS			Height of main shoot at harvest (cm)		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	70.54	68.38	69.46	71.57	69.60	70.58
D_2	71.29	69.82	70.55	73.50	71.42	72.46
D_3	67.75	66.04	66.89	70.04	67.59	68.82
S.E.m±	0.51	0.50	0.36	1.28	1.20	0.88
C.D. (at 5%)	2.01	1.97	1.17	NS	NS	NS
Variety						
V_1	70.47	68.07	69.27	71.35	69.22	70.28
V_2	73.83	72.67	73.25	76.41	74.51	75.46
V_3	71.47	69.66	70.56	73.49	71.04	72.26
V_4	63.66	61.92	62.79	65.56	63.38	64.47
S.E.m±	0.60	0.62	0.43	0.67	0.63	0.46
C.D. (at 5%)	1.69	1.76	1.20	1.89	1.79	1.29
No. of irrigation						
I_1	68.61	66.56	67.58	70.43	68.09	69.26
I_2	71.78	69.52	70.65	73.66	70.94	72.30
I_3	69.18	68.17	68.67	71.01	69.58	70.29
S.E.m±	0.52	0.54	0.37	0.58	0.55	0.40
C.D. (at 5%)	1.46	1.52	1.04	1.64	1.55	1.12

FIG. 12: EFFECT OF DATES OF SOWING ON HEIGHT OF MAIN SHOOT

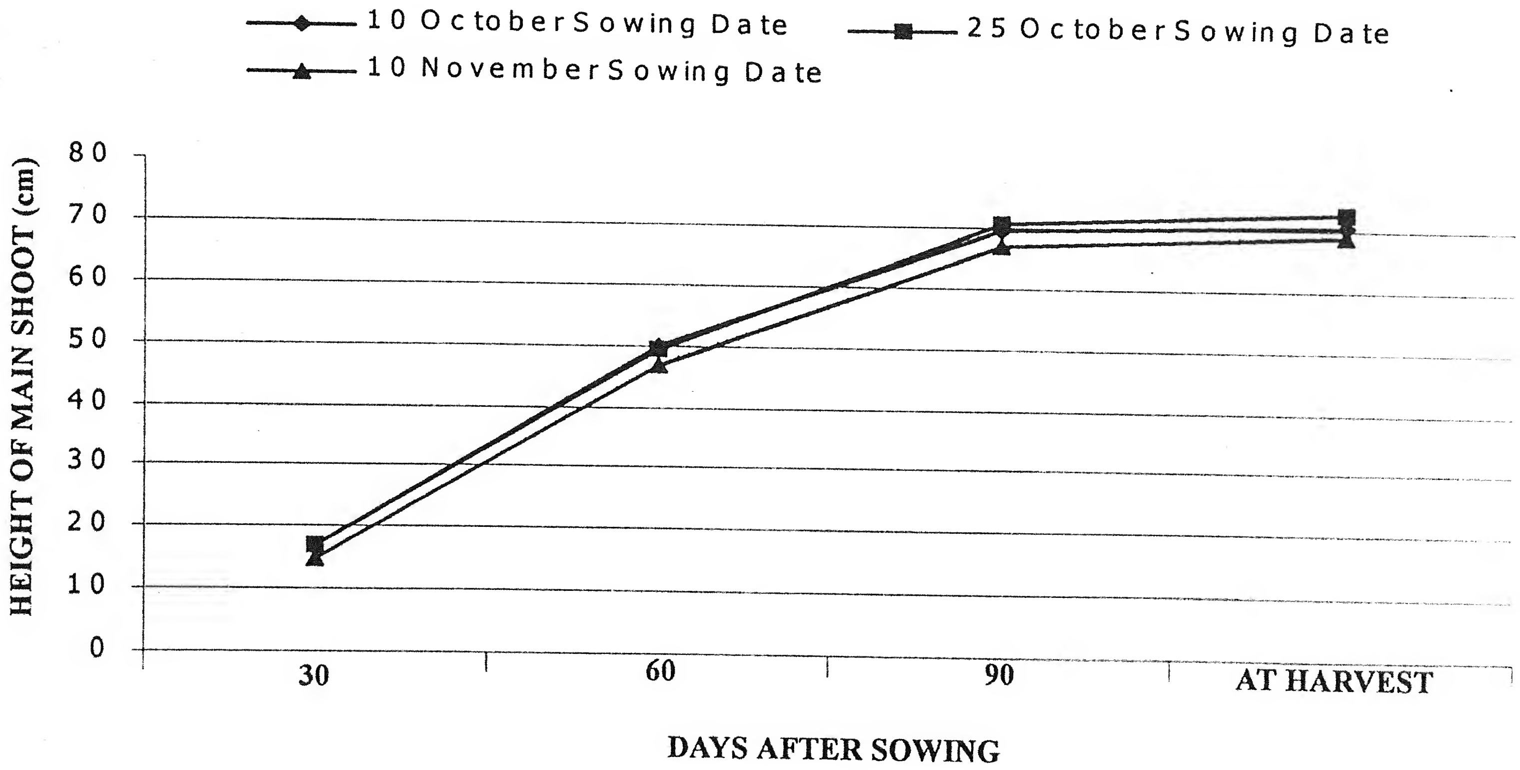


FIG. 13: EFFECT OF VARIETIES ON HEIGHT OF MAIN SHOOT

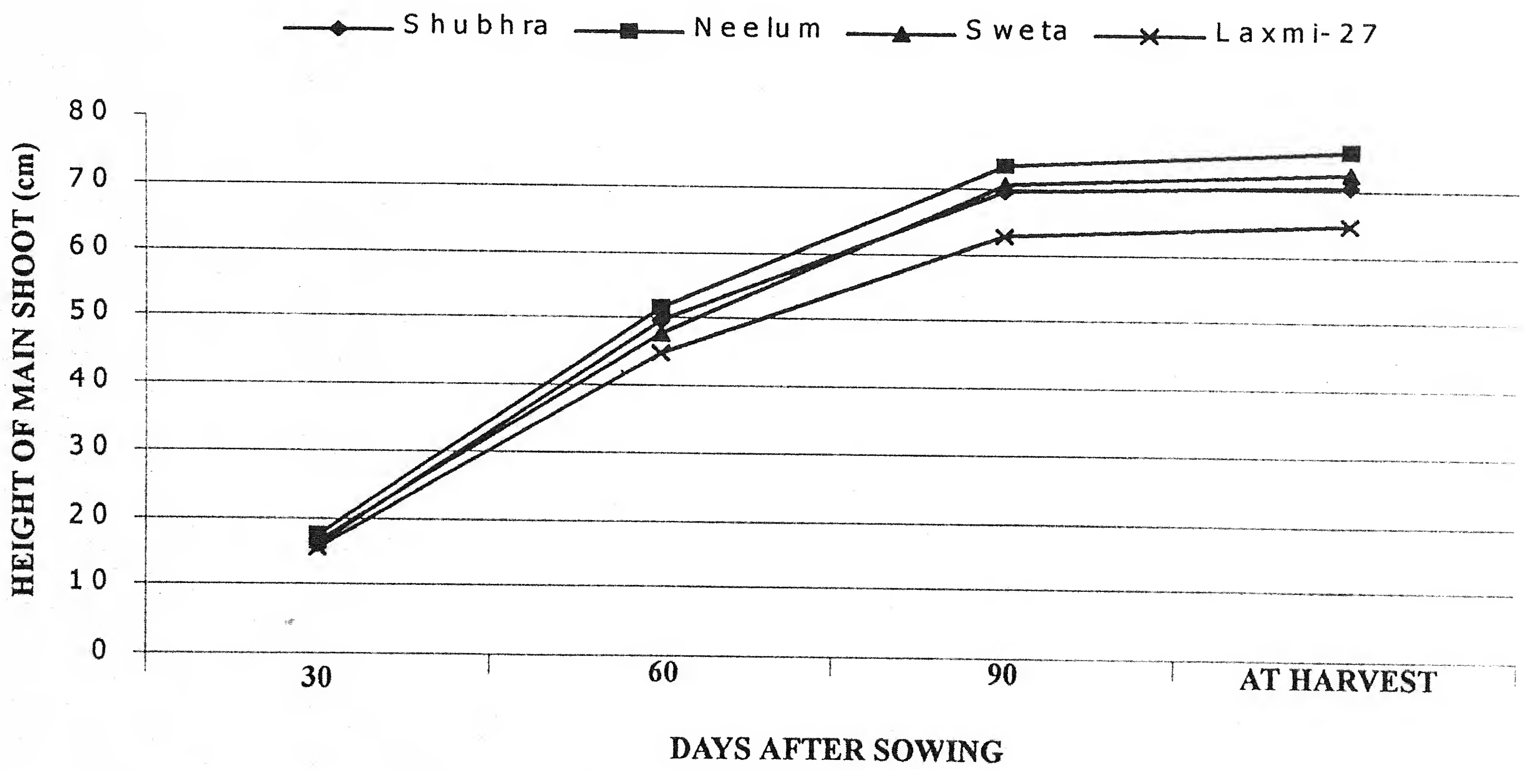
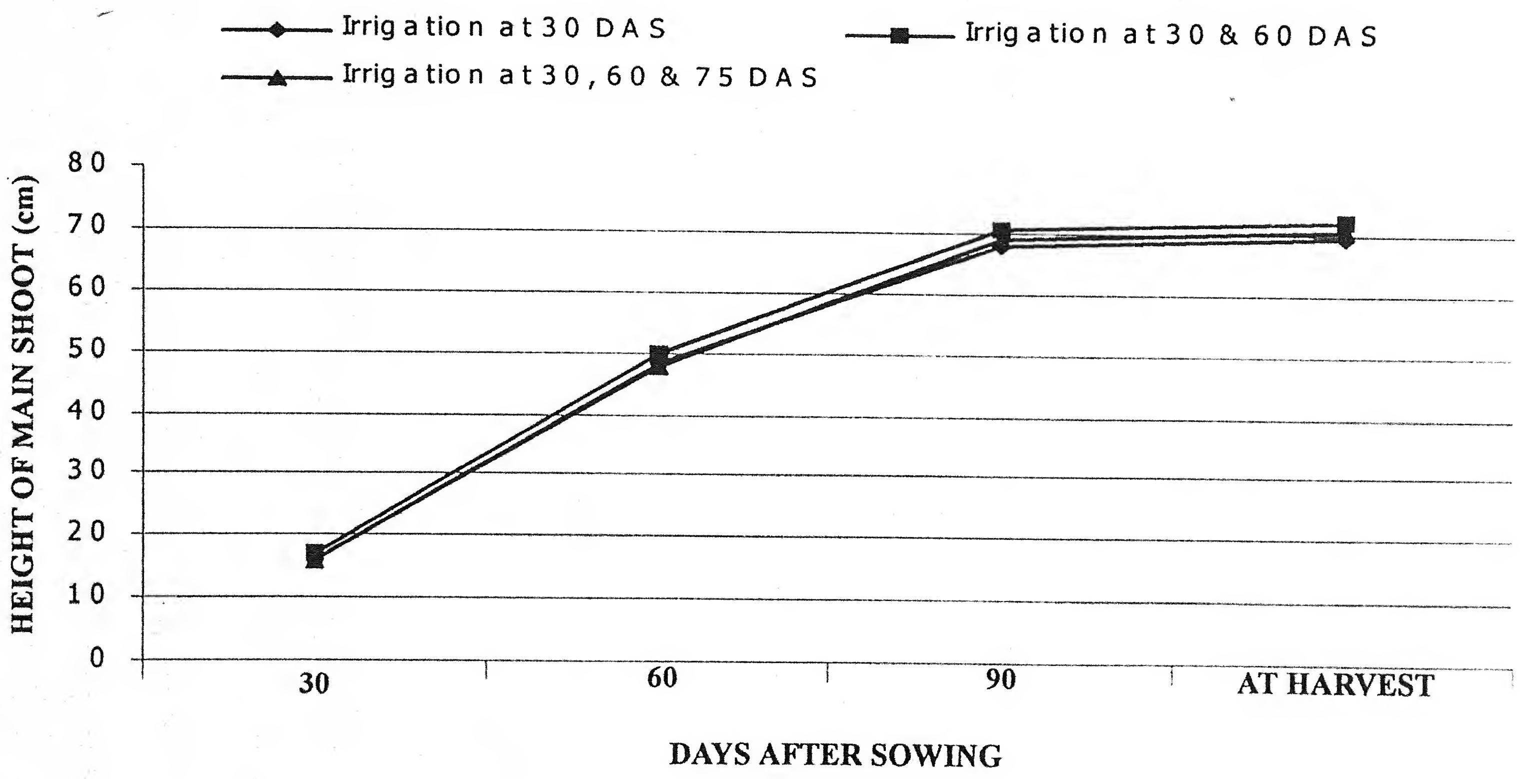


FIG. 14: EFFECT OF IRRIGATION LEVELS ON HEIGHT OF MAIN SHOOT



Number of primary branches/plant:

Number of primary branches/plant as affected by dates of sowing, varieties and irrigation levels is given in table 16(a) to 16(c), appendix 16 and figure 15.

Perusal of table-16(a) indicates that the number of primary branches/plant were significantly affected due to date of sowing of the crop. D_2 (25 October sowing) recorded significantly maximum number of primary branches than D_1 (10 October sowing) which significantly produced higher number of primary branches than D_3 (10 November sowing). Similar trend was also observed in pooled data.

Number of primary branches was also affected due to varieties V_2 (Neelum) produced significantly higher primary branches than V_4 (Laxmi-27), which were significantly superior to V_3 (Sweta), which is also significant to V_1 (Shubhra).

Similar trend was also found in 2nd year with respect to this parameter. In pooled data Neelum was found significant than all the three varieties, which were at par among themselves.

Irrigation frequency also affected the number of primary branches. I_2 (2 irrigation at 30 & 60 DAS) recorded significantly maximum number followed by I_1 (one irrigation at 30 DAS), which was also significant than I_3 (3 irrigation at 30, 60 & 75 DAS). Similar trend was also found in the pooled data with respect to this parameter.

Interaction effect of dates of sowing and varieties on number of primary branches/plant was found to be significant (table-16(b)), which revealed that variety V_2 (Neelum) gave significantly higher number of primary branches/plant than other varieties sown at any dates in the 1^{st} year, 2^{nd} year and in the pooled data of both years. Treatment combination D_2V_2 (25 October sowing date and variety Neelum) significantly produced higher number of primary branches (7.56, 6.78 and 7.17) than other treatment combinations in the 1^{st} year, 2^{nd} year and in pooled data of both years, respectively. However, the minimum number of primary branches/plant (3.71, 3.58 and 3.65) was recorded in D_3V_3 treatment combination, respectively in the 1^{st} year, 2^{nd} year and in the pooled data of both the year.

In the first year 1998, interaction effect of dates of sowing and irrigation levels on number of primary branches/plant was found to be significant (table-16(c)), which revealed that irrigation level I_2 (irrigation at 30 and 60 DAS) gave significantly higher number of branches/plant than other irrigation levels at all dates of sowing. However, irrigation level I_3 (irrigation at 30, 60 and 75 DAS) gave significantly lower number of primary branches/plant than other irrigation levels at all dates of sowing. The highest number of primary branches (7.12/plant) was recorded in D_2I_2 (25 October sowing date and irrigation at 30 and 60 DAS) and lowest number of primary branches (3.46/plant) in D_3I_3 (10 November sowing date and irrigation at 30, 60 and 75 DAS)). The interaction effects VxI and DxVxI were not found upto the significant level.

Table-16(a): Effect of different treatments on number of primary branches/ plant.

Treatment	No. of primary branches		
	1998	1999	Pooled
Date of Sowing			
D_1	4.70	4.48	4.59
D_2	6.08	5.48	5.78
D_3	4.08	3.84	3.96
S.E.m±	0.07	0.08	0.05
C.D. (at 5%)	0.26	0.33	0.16
Variety			
V_1	4.21	3.87	4.04
V_2	6.02	5.76	5.89
V_3	4.50	4.24	4.37
V_4	5.09	4.54	4.81
S.E.m±	0.07	0.10	0.06
C.D. (at 5%)	0.21	0.29	0.18
No. of irrigation			
I_1	4.82	4.43	4.62
I_2	5.78	5.33	5.55
I_3	4.26	4.06	4.16
S.E.m±	0.06	0.09	0.05
C.D. (at 5%)	0.18	0.25	0.14

Table-16(b): Interaction effect of DxV on number of primary branches/plant.

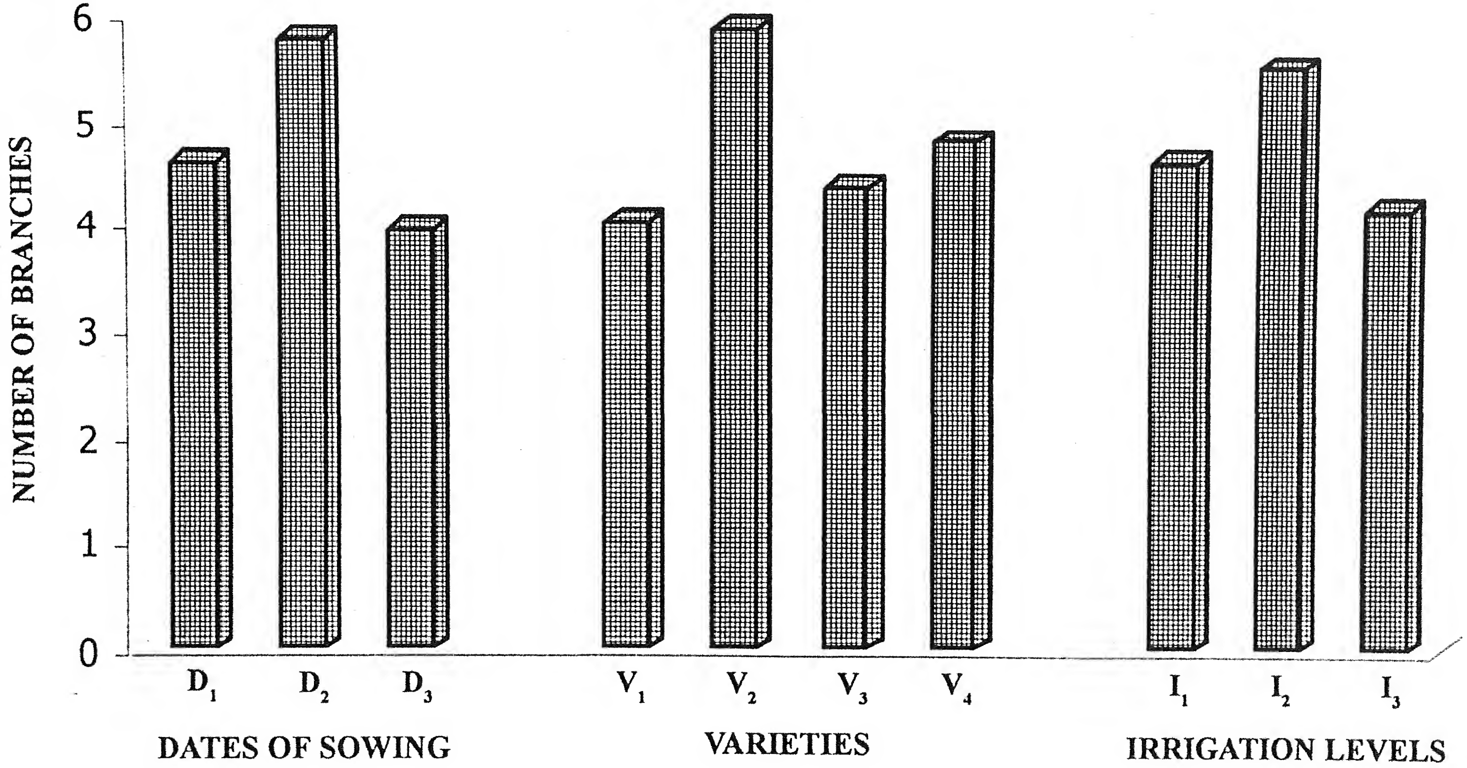
Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	4.00	5.89	4.19	4.72
D_2	4.72	7.56	5.60	6.44
D_3	3.89	4.61	3.71	4.11
2nd Year (1999)				
D_1	3.68	6.03	3.99	4.22
D_2	4.28	6.78	5.16	5.72
D_3	3.65	4.48	3.58	3.67
Pooled				
D_1	3.84	5.96	4.09	4.47
D_2	4.50	7.17	5.38	6.08
D_3	3.77	4.54	3.65	3.89

	S.E.m±	C.D. at 5%
1st Year (1998)	0.13	0.36
2nd Year (1999)	0.18	0.50
Pooled	0.11	0.31

Table-16(c): Interaction effect of DxI on number of primary branches/plant.
(Year-1998)

Irrigation level	Dates of sowing		
	D_1	D_2	D_3
I_1	4.55	5.83	4.09
I_2	5.51	7.12	4.70
I_3	4.04	5.29	3.46
		DxI	
S.E.m±		0.11	
C.D. at 5%		0.31	

FIG. 15: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON NUMBER OF PRIMARY BRANCHES



Number of secondary branches/plant:

Number of secondary branches/plant as affected by dates of sowing, varieties and irrigation levels is given in table 17(a) to 17(d), appendix 17 and figure 16.

Like primary branches/plant, secondary branches were also affected due to date of sowing. D_2 (25 October sowing) recorded significantly higher number of secondary branches in both the years and in pooled data than D_1 (10 October sowing), which was significantly superior to D_3 with this parameter in both the years and in the pooled data (table-17(a)).

V_2 (Neelum) and V_4 (Laxmi-27) recorded significantly maximum number of secondary branches than V_3 (Sweta) and V_1 (Shubhra). V_3 had significantly maximum secondary branches than V_1, which had the minimum secondary branches. The difference in V_2, V_1 and V_3 were also significant in both the years and in the mean of two years. As regards irrigation levels, I_2 level produced significantly maximum number of secondary branches than D_3 while I_2 and I_1 were at par in both the years and in the pooled data.

Interaction between dates of sowing and varieties with regards to number of secondary branches/plant was found to be significant (table-17(b)), which indicated that variety V_2 (Neelum) significantly enhanced the number of secondary branches/plant as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. The maximum number of secondary branches of 25.63, 24.00 and 24.82/plant was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum number of secondary branches of 11.22, 10.54 and 10.88/plant was recorded from D_3V_1 (10 November

sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively.

In the second year 1999, interaction effect of dates of sowing and irrigation levels on number of secondary branches/plant was found to be significant (table-17(c)), which revealed that irrigation level I_2 (irrigation at 30 and 60 DAS) gave significantly higher number of secondary branches/plant than other irrigation levels at all dates of sowing. However, irrigation level I_3 (irrigation at 30, 60 and 75 DAS) gave significantly lower number of secondary branches/plant than other irrigation levels at all dates of sowing. The highest number of secondary branches (21.89/plant) was recorded in D_2I_2 (25 October sowing date and irrigation at 30 and 60 DAS) and lowest number of secondary branches (11.67/plant) in D_3I_3 (10 November sowing date and irrigation at 30, 60 and 75 DAS)).

In the second year 1999, interaction effect of variety and irrigation levels on number of secondary branches/plant was found to be significant (table-17(d)), which revealed that the treatment combination V_2I_2 (variety Neelum and irrigation at 30 and 60 DAS) significantly produced higher number of secondary branches/plant than other treatment combinations. However, the lowest number of secondary branches/plant was recorded in treatment combination V_1I_3 (variety Shubhra and irrigation at 30, 60 and 75 DAS)) which was significantly inferior to all other treatment combinations except V_1I_1 (variety Shubhra and irrigation at 30 DAS). The second order interaction effect DxVxI was not found upto the significant level.

Table-17(a): Effect of different treatments on number of secondary branches/ plant.

Treatment	No. of secondary branches/plant		
	1998	1999	Pooled
Date of Sowing			
D_1	17.96	16.77	17.35
D_2	20.53	19.09	19.81
D_3	13.91	13.19	13.55
S.E.m±	0.09	0.10	0.07
C.D. (at 5%)	0.34	0.39	0.23
Variety			
V_1	13.88	12.81	13.34
V_2	21.58	20.23	20.91
V_3	16.07	15.07	15.57
V_4	18.33	17.30	17.81
S.E.m±	0.32	0.19	0.19
C.D. (at 5%)	0.89	0.55	0.53
No. of irrigation			
I_1	17.31	16.08	16.69
I_2	19.66	18.49	19.08
I_3	15.43	14.48	14.95
S.E.m±	0.27	0.17	0.16
C.D. (at 5%)	0.77	0.47	0.45

Table-17(b):Interaction effect of DxV on number of secondary branches/plant.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	13.72	22.06	17.33	18.72
D_2	16.70	25.63	17.88	21.89
D_3	11.22	17.06	13.00	14.37
2nd Year (1999)				
D_1	12.56	20.56	16.10	17.88
D_2	15.32	24.00	16.57	20.46
D_3	10.54	16.12	12.52	13.56
Pooled				
D_1	13.14	21.31	16.71	18.30
D_2	16.01	24.82	17.23	21.17
D_3	10.88	16.59	12.76	13.97

	S.E.m±	C.D. at 5%
1st Year (1998)	0.55	1.55
2nd Year (1999)	0.33	0.94
Pooled	0.32	0.90

FIG. 16: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON NUMBER OF SECONDARY BRANCHES

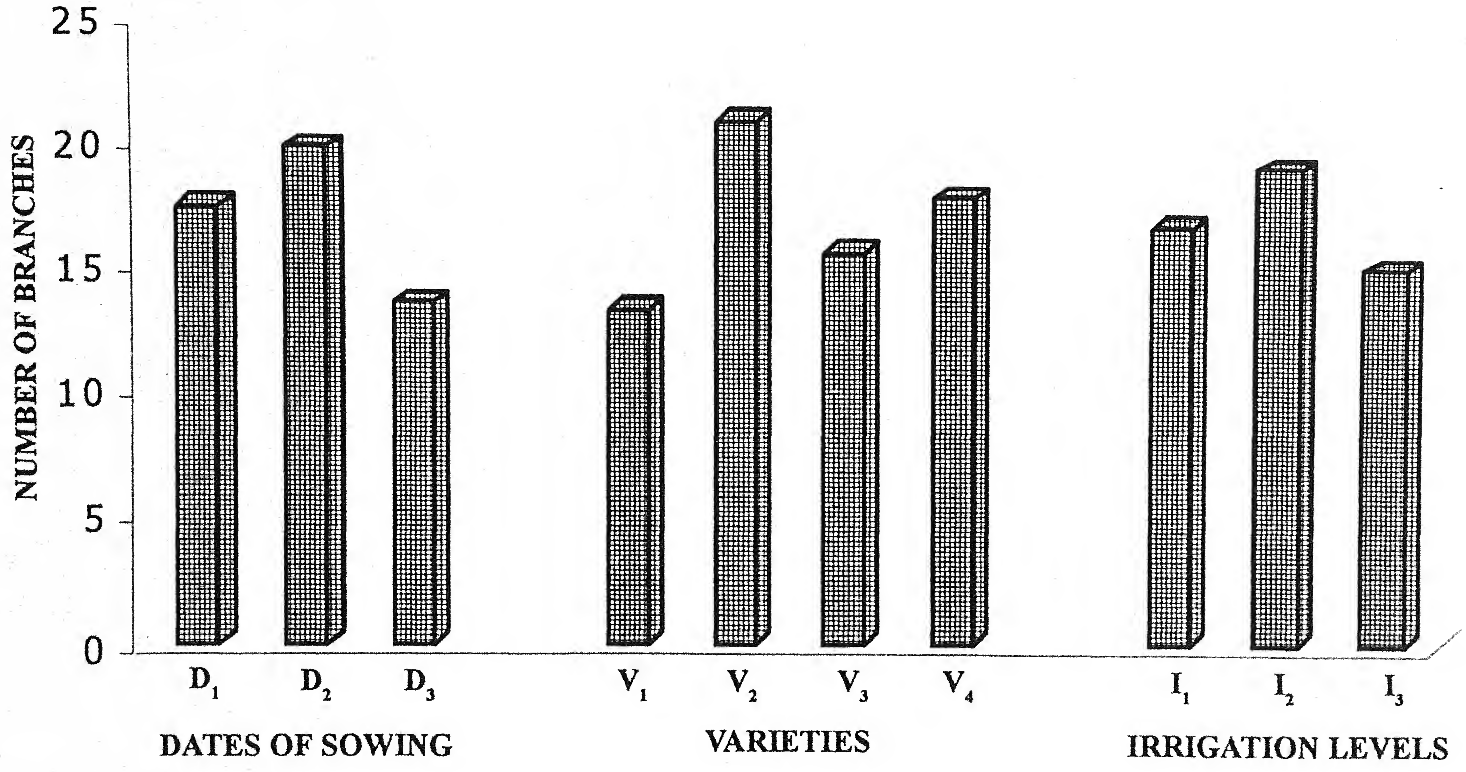


Table-17(c):Interaction effect of DxI on number of secondary branches/plant.

(Year-1999)

Irrigation level	Dates of sowing		
	D_1	D_2	D_3
I_1	16.22	18.87	13.14
I_2	18.84	21.89	14.75
I_3	15.26	16.50	11.67
		DxI	
S.E.m±		0.26	
C.D. at 5%		0.82	

Table-17(d): Interaction effect of VxI on number of secondary branches/plant.

(Year-1999)

Varieties	Irrigation levels		
	I_1	I_2	I_3
V_1	12.27	14.60	11.56
V_2	20.10	22.22	18.36
V_3	14.40	17.24	13.56
V_4	17.55	19.90	14.43
		VxI	
S.E.m±		0.33	
C.D. at 5%		0.94	

Number of tertiary branches/plant:

Number of tertiary branches/plant as affected by date of sowing, varieties and number of irrigation is given in table 18(a) to 18(b), appendix 18 and fig. 17.

It is evident from table-18(a) that number of tertiary branches/plant were significantly affected in both the years and in the pooled data. According to order of significance the dates of sowings were as follows:

D_2, D_1 followed by D_3. The difference between D_2 and D_1 was also significant for this parameter. The trend of the result was similar in both the years and in the mean of the two years.

Amongst the varieties Neelum (V_2) recorded significantly maximum number of tertiary branches, followed by Laxmi-27 and Sweta while Shubhra (V_1) had the lowest number of this parameter. The same order was found in both the years and in the mean of two years.

Irrigation levels also affected the number of tertiary branches/plant, I_2 (2 irrigations at 30 & 60 DAS) produced the maximum number significantly higher than I_1 (irrigation at 30 DAS) and I_3 (3 irrigations at 30, 60 & 75 DAS). The difference between I_2, I_1 and I_3 was significant in both the years and in pooled data.

Interaction between dates of sowing and varieties with regards to number of tertiary branches/plant was found to be significant (table-18(b)), which indicated that variety V_2 (Neelum) significantly enhanced the number of tertiary branches/plant as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest number of tertiary branches/plant which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum number of tertiary branches of 52.12, 49.95 and 51.04/plant was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum number of tertiary branches of 21.07, 19.27 and 20.17/plant was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively. The interaction effects DxI, VxI and DxVxI were not found upto the significant level.

Table-18(a): Effect of different treatments on number of tertiary branches/plant.

Treatment	No. of tertiary branches/plant		
	1998	1999	Pooled
Date of Sowing			
D_1	37.11	35.05	36.08
D_2	41.27	39.52	40.39
D_3	29.08	27.17	28.12
S.E.m±	0.32	0.39	0.25
C.D. (at 5%)	1.25	1.52	0.82
Variety			
V_1	28.04	26.37	27.20
V_2	45.40	43.22	44.31
V_3	32.47	30.86	31.66
V_4	37.38	35.21	36.29
S.E.m±	0.53	0.49	0.36
C.D. (at 5%)	1.48	1.39	1.01
No. of irrigation			
I_1	35.45	33.32	34.38
I_2	40.08	37.86	38.97
I_3	31.94	30.57	31.25
S.E.m±	0.46	0.43	0.31
C.D. (at 5%)	1.29	1.20	0.87

Table-18(b): Interaction effect of DxV on number of tertiary branches/plant.

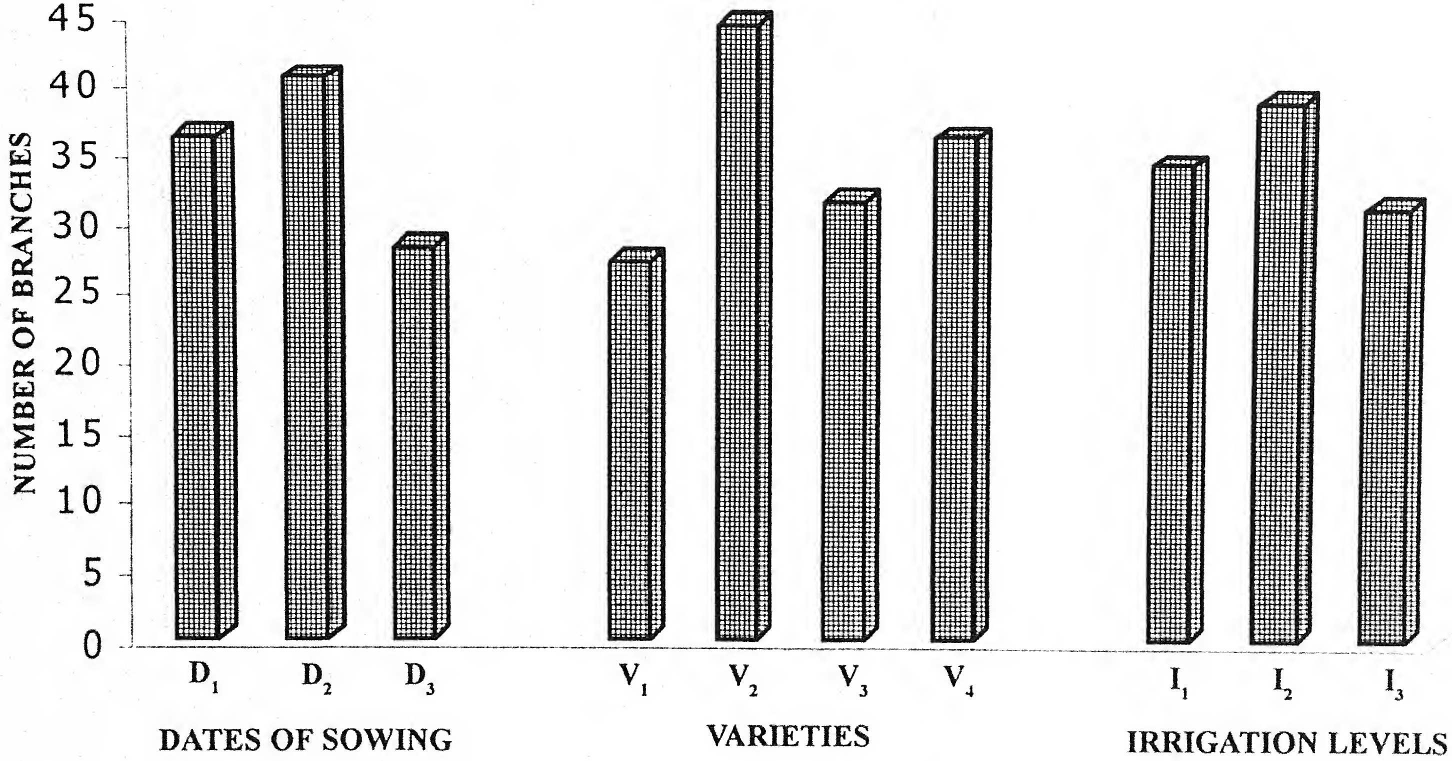
Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	31.06	44.09	34.51	38.78
D_2	31.99	52.12	36.55	44.42
D_3	21.07	39.99	26.35	28.92
2nd Year (1999)				
D_1	29.07	41.72	32.54	36.88
D_2	30.78	49.95	35.82	41.54
D_3	19.27	37.98	24.22	27.21
Pooled				
D_1	30.06	42.90	33.53	37.83
D_2	31.39	51.04	36.19	42.98
D_3	20.17	38.99	25.28	28.07

	S.E.m±	C.D. at 5%
1st Year (1998)	0.91	2.57
2nd Year (1999)	0.85	2.40
Pooled	0.62	1.75

Number and weight of capsules/plant:

Number and weight of capsules/plant as affected by date of sowing, varieties and irrigation frequencies, are given in table 19(a) to 19(c), appendix 19 to 20 and figure 18 to 19.

FIG. 17: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON NUMBER OF TERTIARY BRANCHES



It is clear from table-19(a) that D_2 produced the maximum number of capsules and also the weight of capsules/plant than D_1 (10 October sowing) & D_3 (10 November sowing). Among the D_2, D_1 and D_3 dates of sowing the difference was significant both in number and weight of capsules/plant. The similar trend was noticed in both the years and mean of the two years in number and weight of capsule/plant.

The difference in number of capsules/plant was noticed significant among the four varieties of the trial. Significantly maximum number of capsules were recorded in V_2 (Neelum), followed by V_4 (Laxmi-27) and V_3 (Sweta) than V_1 (Shubhra) in both the years and in the mean of two years. The difference in weight of capsule/plant was also significant among the varieties.

Like date of sowing and varieties, frequency of irrigation has also affected both the number and weight of capsules/plant. Significant higher number and maximum weight of capsule/plant was recorded in I_2 (2 irrigation at 30 and 60 DAS) followed by I_1 (irrigation at 30 DAS) and I_3 (3 irrigations at 30, 60 and 75 DAS) in both the years. The difference among the frequency of irrigation with respect of number and weight of capsule/plant was also significant in both the years and in the mean of two years. The trend in number and weight of capsules per plant was almost similar in both the years and mean of two years.

Interaction effect of dates of sowing and varieties on number of capsules/plant was found to be significant (table-19(b)), which revealed that variety V_2 (Neelum) gave significantly higher number of capsules/plant than other

varieties sown at D_2 and D_3 dates of sowing in the both years as well as in the pooled data of both years except D_2V_4 in second year. The lowest number of capsules/plant was recorded in V_1 (variety Shubhra) which is significantly inferior than other varieties shown at any dates.

All other 1st and 2nd order interaction effects (DxI, VxI and DxVxI) were not found upto the significant level.

Interaction between dates of sowing and varieties with regards to weight of capsules/plant was found to be significant (table-19(c)), which indicated that variety V_2 (Neelum) significantly enhanced the capsules weight/plant as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest capsules weight/plant which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum capsules weight of 29.00, 28.04 and 28.52 g/plant was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum capsules weight of 10.34, 9.72 and 10.03 g/plant was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively.

The interaction effects DxI, VxI and DxVxI were not found upto the significant level.

Table-19(a): Effect of different treatments on number and weight of capsules/plant (g).

Treatment	No. of capsules/plant			Weight of capsules/plant		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	125.71	117.93	121.82	18.53	17.63	18.08
D_2	137.94	132.01	134.97	21.54	20.42	20.98
D_3	109.16	102.65	105.91	14.69	13.86	14.27
S.E.m±	0.70	0.68	0.49	0.30	0.32	0.22
C.D. (at 5%)	2.74	2.67	1.60	1.17	1.26	0.72
Variety						
V_1	103.59	97.10	100.34	13.31	12.49	12.90
V_2	138.71	132.05	135.38	24.41	23.54	23.97
V_3	123.08	116.43	119.75	16.17	15.08	15.63
V_4	131.71	124.53	128.12	19.11	18.10	18.61
S.E.m±	0.71	0.75	0.52	0.29	0.31	0.21
C.D. (at 5%)	2.01	2.11	1.45	0.82	0.88	0.59
No. of irrigation						
I_1	123.81	116.95	120.38	17.90	17.00	17.45
I_2	134.88	127.63	131.25	21.08	20.19	20.63
I_3	114.11	108.00	111.06	15.78	14.73	15.26
S.E.m±	0.62	0.65	0.45	0.25	0.27	0.19
C.D. (at 5%)	1.74	1.83	1.26	0.71	0.77	0.53

Table-19(b): Interaction effect of DxV on number of capsules/plant.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	100.51	137.22	125.90	139.21
D_2	115.81	153.11	136.12	146.72
D_3	94.45	125.78	107.20	109.21
2nd Year (1999)				
D_1	94.61	130.27	118.95	127.88
D_2	110.02	146.13	129.06	142.82
D_3	86.66	119.77	101.30	102.88
Pooled				
D_1	97.56	133.74	122.42	133.54
D_2	112.92	149.62	132.59	144.77
D_3	90.56	122.77	104.25	106.05

	S.E.m±	C.D. at 5%
1st Year (1998)	1.23	3.48
2nd Year (1999)	1.30	3.66
Pooled	0.89	2.51

FIG. 18: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON NUMBER OF CAPSULES/PLANT

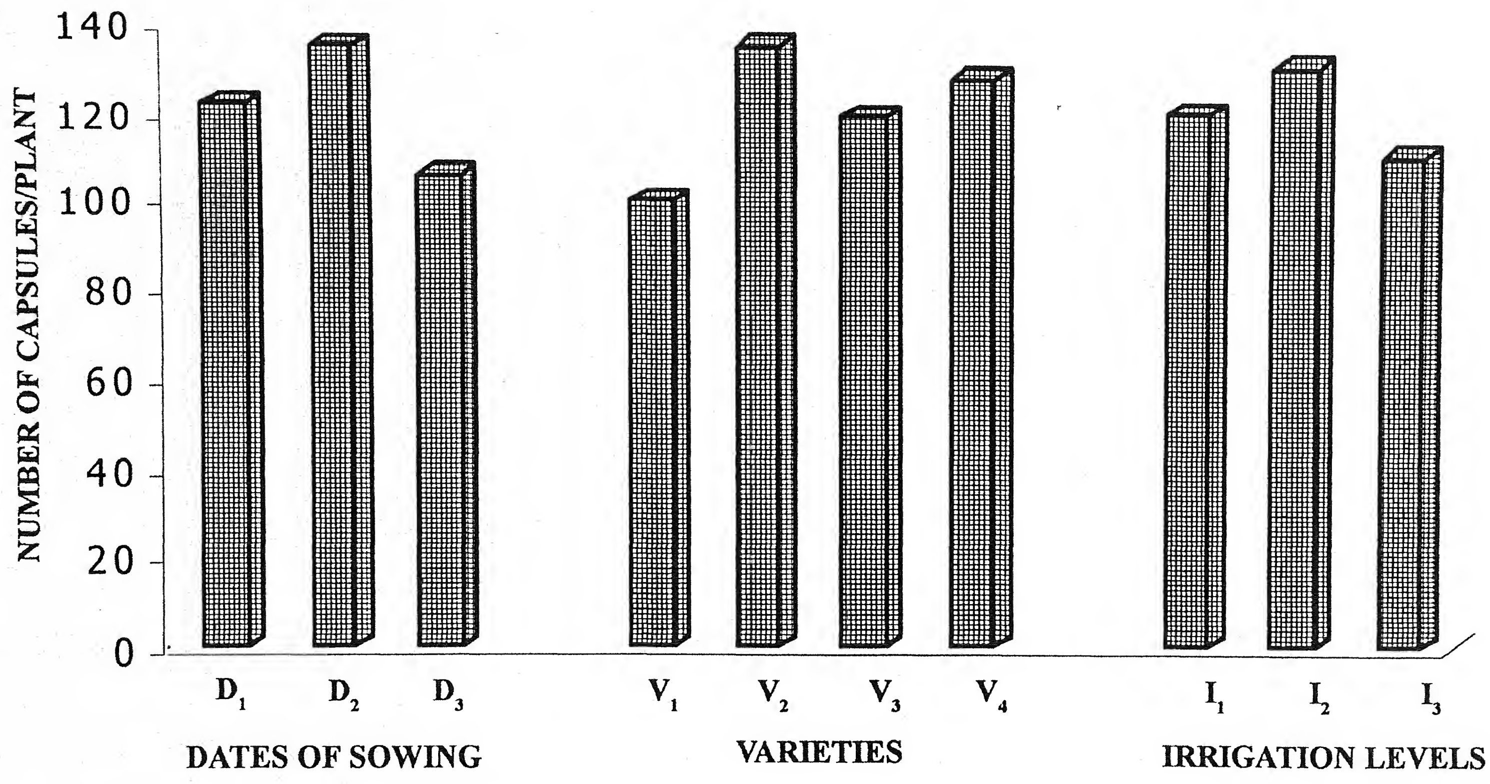


FIG. 19: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON WEIGHT OF CAPSULES/PLANT

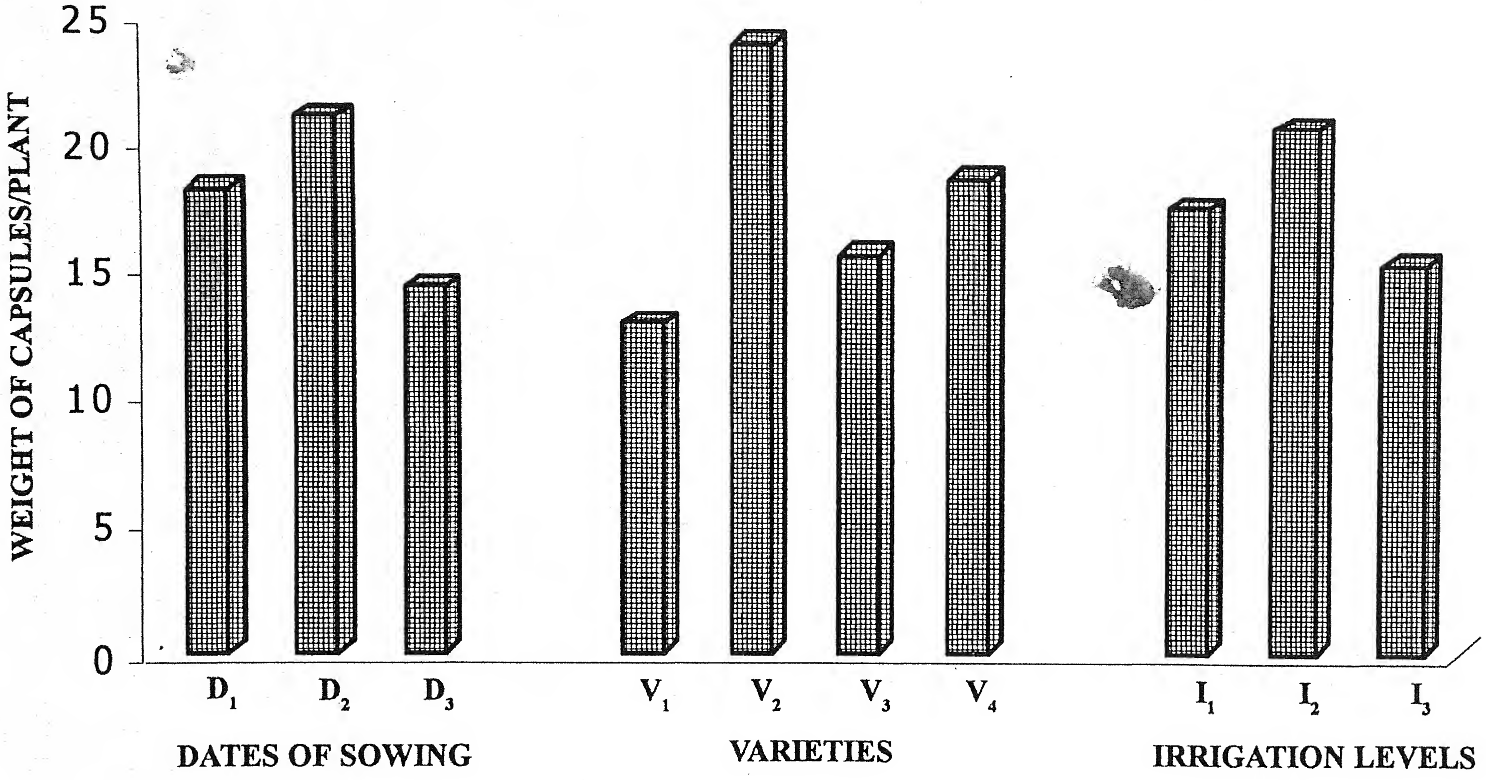


Table-19(c): Interaction effect of DxV on weight of capsules/plant.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	13.73	25.34	16.67	18.39
D_2	29.00	29.00	18.83	22.45
D_3	10.34	18.89	13.01	16.50
2nd Year (1999)				
D_1	12.71	24.55	15.78	17.48
D_2	15.03	28.04	17.32	21.28
D_3	9.72	18.04	12.14	15.55
Pooled				
D_1	13.22	24.95	16.22	17.93
D_2	15.45	28.52	18.08	21.87
D_3	10.03	18.46	12.57	16.02

	S.E.m±	C.D. at 5%
1st Year (1998)	0.50	1.43
2nd Year (1999)	0.54	1.53
Pooled	0.37	1.04

Number and weight of seeds/capsule:

Number of seed and weight of seeds/capsule as affected by sowing dates, varieties and irrigation frequency is given in table 20(a) to 20(c), appendix 21 to 22 and figure 20 to 21.

It is clearly evident from table-20(a) that number of seed and weight of seed per capsule was significantly affected by the sowing dates of linseed. Number of seed/capsule was significantly higher in D_2 (25 October sowing) followed by D_1 (10 October sowing) and D_3 (10 November sowing). Difference in this parameter among different dates of sowing was significant. This trend was noticed in both the years and in the mean of two years. In case of weight of seed/capsule, the maximum was recorded in D_2, followed by D_1 and D_3 date of sowing. Difference among these dates of sowing of the crop was also significant in both the years and in the mean of two years.

In case of variety, variety Neelum significantly produced higher no. of seeds/capsule as well as weight of seed/capsule than other varieties (except V_4 in case of number of seeds/capsule).

Irrigation levels in the trial also affected the number and weight of seeds/capsule. Significantly higher number of capsules was recorded in I_2 level (2 irrigations at 30 & 60 DAS) followed by I_1 (1 irrigation at 30 DAS) and I_3 produced significantly lower number of capsules/plant. Significant difference among level of irrigation was found in both the years and in the mean of two years. Significant difference in weight of seed per capsule was also noticed in I_2, followed by I_1 & I_3 level of irrigation. This trend in weight of seed/capsule was also observed in both the years and in the mean of two years.

Table-20(a): Effect of different treatments on number and weight of seeds/ capsule.

Treatment	No. of seed/capsules			Weight of seed/capsules (mg)		
	1998	1999	Pooled	1998	1999	Pooled
Date of Sowing						
D_1	7.75	7.20	7.47	31.87	31.08	31.47
D_2	8.15	7.54	7.84	33.29	32.47	32.88
D_3	7.09	6.71	6.90	29.94	29.24	29.59
S.E.m±	0.09	0.11	0.07	0.42	0.48	0.32
C.D. (at 5%)	0.38	0.42	0.23	1.64	1.89	1.04
Variety						
V_1	6.90	6.55	6.72	30.85	30.32	30.58
V_2	8.53	7.81	8.17	32.88	32.14	32.47
V_3	7.10	6.76	6.93	31.62	30.71	31.17
V_4	8.13	7.49	7.81	31.46	30.55	31.00
S.E.m±	0.15	0.15	0.10	0.26	0.22	0.17
C.D. (at 5%)	0.42	0.41	0.28	0.75	0.62	0.48
No. of irrigation						
I_1	7.63	7.03	7.33	31.70	30.71	31.20
I_2	8.29	7.78	8.03	32.13	31.52	31.83
I_3	7.06	6.64	6.85	31.27	30.57	30.92
S.E.m±	0.13	0.13	0.09	0.23	0.19	0.15
C.D. (at 5%)	0.37	0.36	0.25	0.65	0.54	0.42

Perusal of the data presented in table-20(b) revealed that the combined effect of dates of sowing and varieties on number of seeds/capsule was found to be significant during first year 1998. The maximum number of seeds/capsule (9.31) recorded in treatment combination D_2V_2 (25 October sowing date and variety Neelum) which is significantly superior to all other treatment combinations except D_1V_4 and D_2V_4.

Perusal of the data presented in table-20(c) revealed that the combined effect of dates of sowing and varieties on weight of seeds/capsule was found to be significant during second year 1999. The highest weight of seeds/capsule (34.17 g) recorded in treatment combination D_2V_2 (25 October sowing date and variety Neelum), which is significantly superior to all other treatment combinations. However, the lowest weight of seeds/capsule (28.39 g) was noticed in treatment combination D_3V_4 (10 November sowing date and variety Laxmi-27) which is significantly inferior to all other treatment combinations except D_3V_3.

The interaction effects (DxI, VxI and DxVxI) on number of seeds and weight of seeds/capsules were not found upto the significant level.

Table-20(b): Interaction effect of DxV on number of seeds/capsule. (Year-1998)

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
D_1	6.72	8.39	7.17	8.72
D_2	7.06	9.31	7.51	8.71
D_3	6.91	7.89	6.63	6.94
		DxV		
S.E.m±		0.26		
C.D. at 5%		0.73		

FIG. 20: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON NUMBER OF SEEDS/CAPSULE

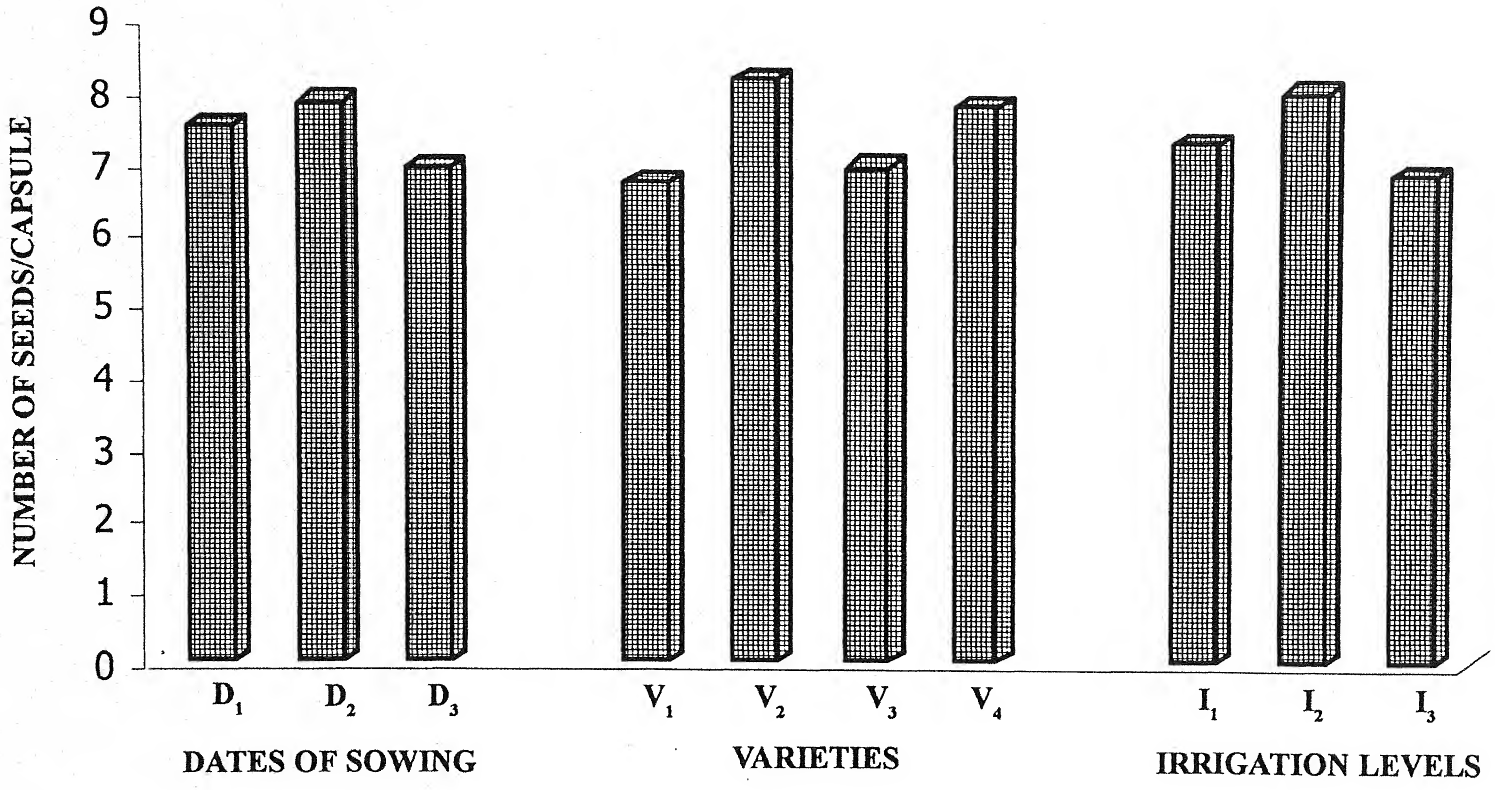


FIG. 21: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON WEIGHT OF SEEDS/CAPSULE

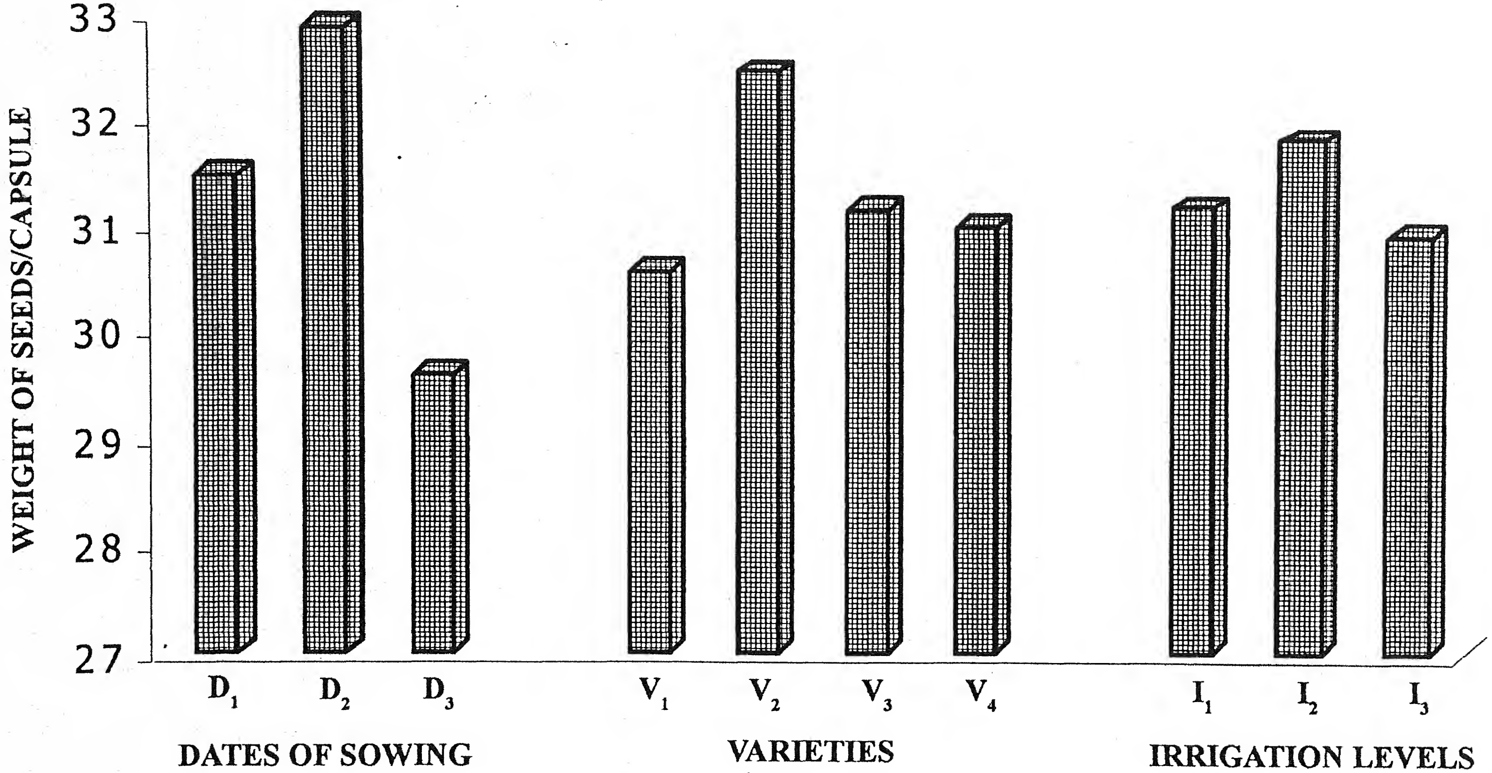


Table-20(c): Interaction effect of DxV on weight of seeds/capsule.

(Year-1999)

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
D_1	29.94	32.21	31.08	31.07
D_2	31.07	34.17	32.43	32.20
D_3	29.95	30.03	28.61	28.39
		DxV		
S.E.m±		0.37		
C.D. at 5%		1.03		

Weight of capsule:

Weight of capsule (mg) as affected by dates of sowing, varieties and irrigation levels is given in table 21(a) to 21(d), appendix 23 and depicted in figure 22.

It is clear from the table-21(a) that D_2 (25 October sowing date) produced the maximum capsule weight as compared to sowing dates D_1 (10 October) and D_3 (10 November) in both the years as well as in pooled data. Among the dates of sowing D_1 and D_3 the difference was found significant.

The difference in capsule weight was noticed significant among the four varieties. Significant maximum weight of capsule was recorded in V_2 (Neelum) followed by V_4 (Laxmi-27), V_3 (Sweta) and V_1 (Shubhra) in both the years and in pooled data of both the years.

Like date of sowing and varieties, irrigation levels were also affected the weight of capsule in both the years and in pooled data. Significant maximum

weight of capsule was recorded in I_2 (irrigation at 30 and 60 DAS) followed by I_1 (irrigation at 30 DAS) and I_3 (irrigation at 30, 60 and 75 DAS). The difference between the effect of irrigation level I_1 and I_3 was also found significant.

Table-21(a): Effect of different treatments on weight of capsule.

Treatment	Weight of capsule (mg)		
	1998	1999	Pooled
Date of Sowing			
D_1	134.50	132.33	133.46
D_2	145.37	141.65	143.51
D_3	122.31	117.91	120.11
S.E.m±	1.36	1.30	0.94
C.D. (at 5%)	5.35	5.13	3.07
Variety			
V_1	110.78	107.54	109.16
V_2	159.03	154.95	156.99
V_3	127.48	124.29	125.88
V_4	139.08	135.75	137.42
S.E.m±	0.99	0.88	0.66
C.D. (at 5%)	2.80	2.49	1.85
No. of irrigation			
I_1	133.21	130.19	131.70
I_2	145.67	141.88	143.77
I_3	123.40	119.82	121.61
S.E.m±	0.86	0.77	0.58
C.D. (at 5%)	2.43	2.16	1.62

The first order interaction between dates of sowing and varieties with regards to weight of capsule was found to be significant (table-21(b)), which revealed that variety V_2 (Neelum) gave significantly higher capsule weight than other varieties sown at any dates (except V_4 sown on 10 October) in the first year, second year and in the pooled data of both years. However, variety V_1 (Shubhra) produced significantly lower capsule weight than other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum capsule weight of 180.61, 176.66 and 17864 mg was secured from D_2V_2 (25 October sowing date and variety Neelum) while minimum capsule weight of 95.46, 91.54 and 93.50 mg was obtained from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in the pooled data of both years, respectively.

Interaction effect of dates of sowing and irrigation levels on weight of capsule during first year 1998 was found to be significant (table-21(c)). The irrigation level I_2 (irrigation at 30 and 60 DAS) significantly produced maximum weight of capsule as compared to other level of irrigations at any dates of sowing. However, the minimum weight of capsule recorded in irrigation level I_3 (irrigation at 30, 60 and 75 DAS) which is significantly inferior to all other levels of irrigation at any dates of sowing.

The first order interaction between varieties and irrigation levels with regards to weight of capsule was found to be significant (table-21(d)), which revealed that treatment combination V_2I_2 (variety Neelum and irrigation at 30 and

60 DAS) gave significantly higher capsule weight than other treatment combinations while lowest capsule weight was recorded in treatment combination V_1I_3 (variety Shubhra and irrigation at 30, 60 and 75 DAS)) which is significantly inferior to all other treatment combinations in the first year, second year and in the pooled data of both years. The second order interaction effect DxVxI was not found upto the significant level.

Table-21(b): Interaction effect of DxV on weight of capsule (mg).

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	117.78	148.27	125.80	146.53
D_2	119.09	180.61	134.56	147.23
D_3	95.46	148.21	122.08	123.48
2nd Year (1999)				
D_1	115.48	145.21	123.32	145.30
D_2	115.59	176.66	131.04	143.32
D_3	91.54	142.99	118.50	118.62
Pooled				
D_1	116.63	146.74	124.56	145.91
D_2	117.34	178.64	132.80	145.27
D_3	93.50	145.60	120.29	121.05

	S.E.m±	C.D. at 5%
1st Year (1998)	1.72	4.85
2nd Year (1999)	1.53	4.32
Pooled	1.15	3.23

Table-21(c):Interaction effect of DxI on weight of capsule (mg). (Year-1998)

Irrigation level	Dates of sowing		
	D_1	D_2	D_3
I_1	134.92	142.57	122.14
I_2	146.96	158.92	131.12
I_3	121.91	134.63	113.66

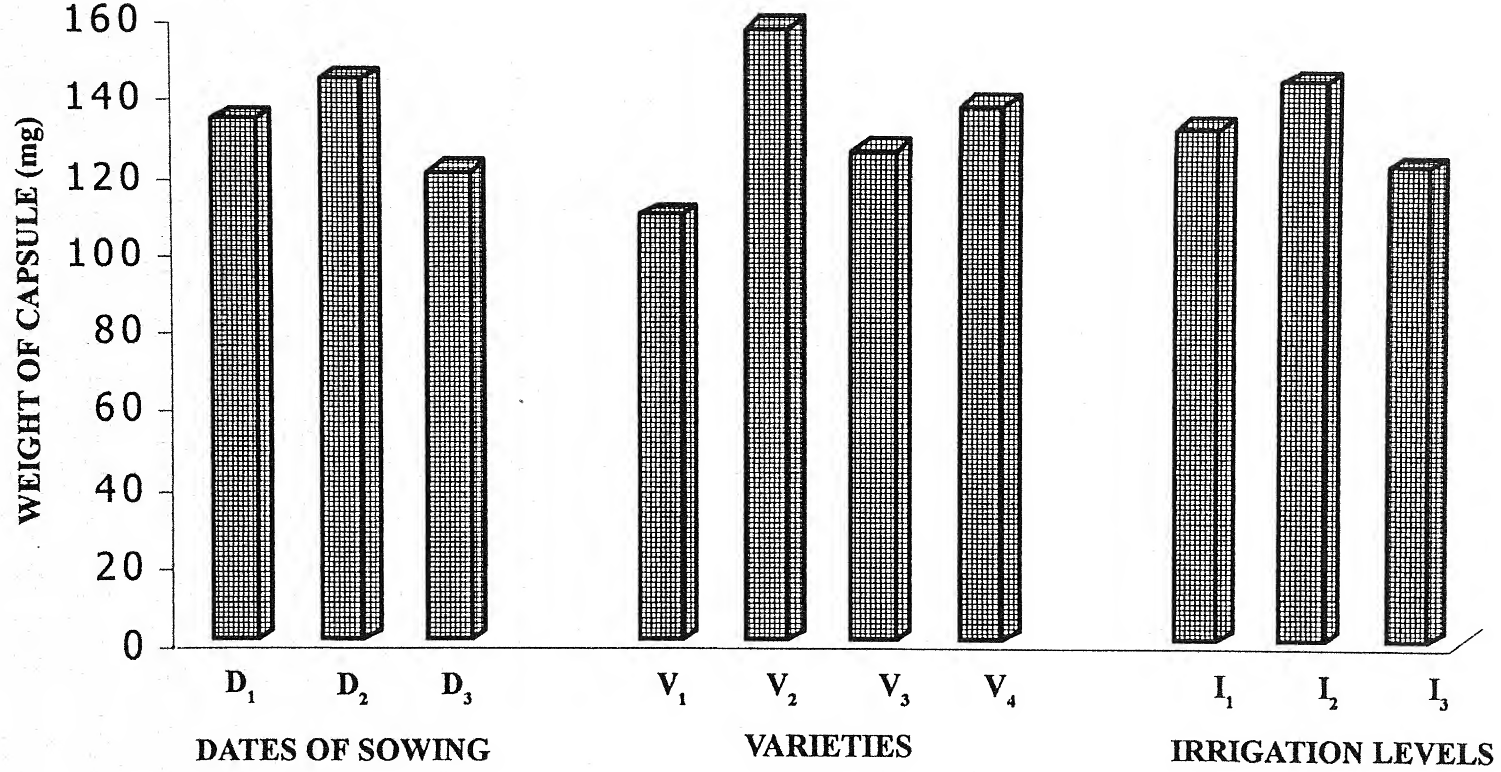
	DxI
S.E.m±	1.49
C.D. at 5%	4.20

Table-21(d): Interaction effect of VxI on weight of capsule (mg).

Varieties	Irrigation levels		
	I_1	I_2	I_3
1st Year (1998)			
V_1	109.49	121.06	101.78
V_2	154.71	171.83	150.55
V_3	126.79	137.27	118.38
V_4	141.85	152.50	122.89
2nd Year (1999)			
V_1	106.47	117.99	98.15
V_2	152.50	167.04	145.31
V_3	123.88	133.84	115.15
V_4	137.92	148.65	120.67
Pooled			
V_1	107.98	119.52	99.96
V_2	153.61	169.43	147.93
V_3	125.33	135.56	116.77
V_4	139.89	150.57	121.78

	S.E.m±	C.D. at 5%
1st Year (1998)	1.72	4.85
2nd Year (1999)	1.53	4.32
Pooled	1.15	3.23

FIG. 22: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON WEIGHT OF CAPSULE



Weight of seeds/plant:

Weight of seed/plant as affected by sowing dates, varieties and irrigation levels of given in table 22(a) to 22(b), appendix 24 and figure 23.

It is revealed from table-22(a) that weight of seed per plant is affected due to dates of sowing. D_2 produced maximum seed weight followed by D_1 and D_3 dates of sowing. The difference in seed weight/plant of these dates is significant in both the years and in the pooled data.

Seed weight/plant is maximum as per the above latile in V_2 (Neelum) followed by V_4 (Laxmi-27), V_3 (Sweta) and V_1 (Shubhra). The difference in weight/plant in these varieties is significant in both the years and in pooled data.

Irrigation applied in the trial crop in both the years affected the seed weight/plant I_2 (2 irrigations at 30 & 60 DAS) recorded the maximum seed weight followed by I_1 and I_3 (3 irrigations 30, 60 and 75 DAS) in both the years and in the mean of two years. The difference among irrigation levels for seed weight/plant is significant in both the years and in the mean of two years.

Interaction between dates of sowing and varieties with regards to weight of seeds/plant was found to be significant (table-22(b)), which indicated that variety V_2 (Neelum) significantly enhanced the weight of seeds/plant as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest weight of seeds/plant which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum weight of seeds 22.22, 20.90 and 21.56 g/plant was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum weight of seeds 6.56, 5.74 and 6.15 g/plant was recorded from D_3V_1 (10 November sowing date and variety Shubhra)

in the first year, second year and in pooled data of both years, respectively. The interaction effects DxI, VxI and DxVxI were not found upto the significant level.

Table-22(a): Effect of different treatments on weight of seeds (g)/plant.

Treatment	Weight of seeds (g)/plant		
	1998	1999	Pooled
Date of Sowing			
D_1	13.60	12.61	13.10
D_2	16.30	15.13	15.71
D_3	9.86	8.92	9.39
S.E.m±	0.45	0.42	0.31
C.D. (at 5%)	1.75	1.65	1.01
Variety			
V_1	8.90	8.12	8.51
V_2	18.33	17.26	17.80
V_3	12.22	11.09	11.65
V_4	13.56	12.41	12.98
S.E.m±	0.26	0.24	0.18
C.D. (at 5%)	0.73	0.68	0.50
No. of irrigation			
I_1	12.63	11.65	12.14
I_2	16.04	14.86	15.45
I_3	11.09	10.15	10.62
S.E.m±	0.23	0.21	0.15
C.D. (at 5%)	0.63	0.59	0.42

FIG. 23: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON WEIGHT OF SEEDS/PLANT

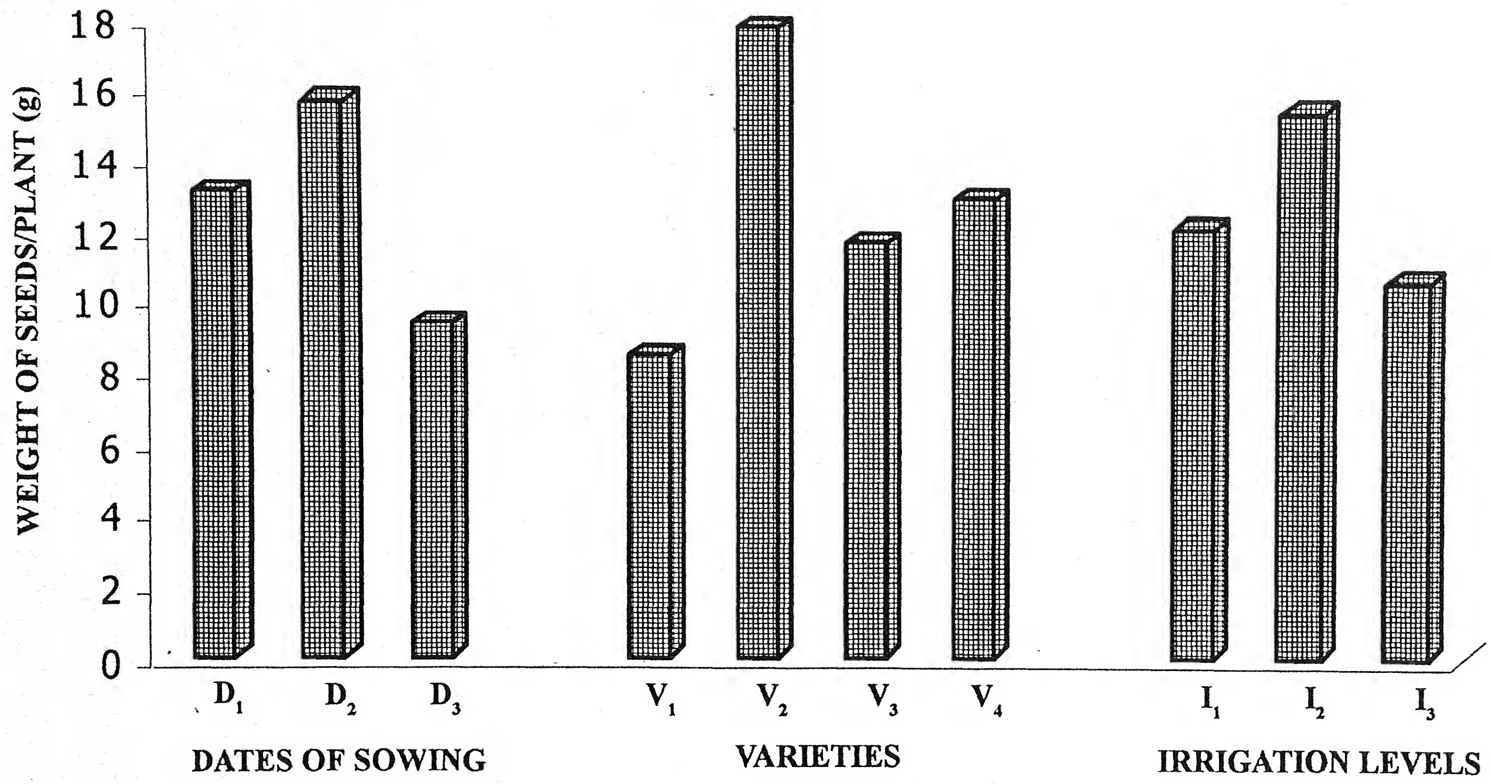


Table-22(b): Interaction effect of DxV on weight of seeds/plant.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	8.28	18.89	13.17	14.06
D_2	11.87	22.21	15.06	16.08
D_3	6.56	13.88	8.45	10.54
2nd Year (1999)				
D_1	7.77	17.81	11.97	12.88
D_2	10.87	20.90	13.89	14.88
D_3	5.74	1306	7.42	9.49
Pooled				
D_1	8.02	18.35	12.57	13.47
D_2	11.37	21.56	14.48	15.48
D_3	6.15	13.47	7.93	10.01

	S.E.m±	C.D. at 5%
1st Year (1998)	0.45	1.27
2nd Year (1999)	0.42	1.18
Pooled	0.31	0.86

Total produce (q/ha):

Total produce quintal per hectare as affected by date of sowing, varieties and irrigation levels is given in table 23(a) to 23(c), appendix 25 and depicted in fig. 24.

Perusal of the data given in table-23(a), it is clear that the date of sowing significantly affected the total produce (grain + stover) q/ha. D_2 (25 October sowing) produced significantly (11.13%) higher yield of produce than D_3 and 17.99% higher than D_1, which recorded 17.39% higher yield than D_3 in 1^{st} year, similarly D_2 produced significantly 65.00% higher than D_3 and 13.8% than D_1 which produced 20.5% higher than D_3 in 2^{nd} year and in the mean of two years, D_2 produced significantly 36.58% higher than D_3 and 17.6% higher than D_1 which recorded 18.9% higher total produce than D_3. Effect of total produce due to different varieties was also significant in both the years and in the mean of two years. The significant highest yield was in V_2 (Neelum) which was 78.46% higher then V_1 (Shubhra), 33.58% high than V_4 (Laxmi-27), 57.7% higher than V_3 (Sweta) in 1^{st} year and 77.02% than V_1, 20.39% higher than V_4, and 56.13% higher than V_3 and in the mean of two year this trend of higher yield of V_2 over V_1, 77.6% higher, 31.07% over V_4 and 25.93% higher over V_3 respectively. V_1 (Shubhra) recorded the lowest total produce than V_2, V_3 and V_4 in both the years and in the mean of the years.

Total produce q/ha was also affect significantly due to irrigation levels in both the years and in the mean of two years. In the year 1998 I_2 (2 irrigation at 30 & 60 DAS) produced 32.77% and in 1999 30.87% significantly higher total produce than D_3 (3 irrigations at 30, 60 and 75 DAS) while I_2 recorded 20.18% higher in 1^{st} year and 21.40 higher total produce then I_1 (1 irrigation at 30 DAS).

In the mean of two year the increase in yield of I_2 over I_3 and I1 was 31.8% and 12.4% of the total produce q/ha.

Interaction between dates of sowing and varieties with regards to total produce (q/ha) was found to be significant (table-23(b)), which indicated that variety V_2 (Neelum) significantly enhanced the total produce as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest total produce which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum total produce of 56.06, 53.29 and 54.68 q/ha was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum total produce of 24.22, 22.44 and 23.33 q/ha was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years (except D_1V_1 in 1st year and 2nd year), respectively.

Interaction effect of VxI on total produce during 1st year 1998 was found significant. The treatment combination V_2I_2 (variety Neelum and irrigation at 30 and 60 DAS) significantly produced maximum total produce (57.72 q/ha) as compared to all other treatment combinations. While treatment combination V_1I_3 (variety Shubhra and irrigation at 30, 60 and 75 DAS)) recorded significantly minimum total produce (23.78 q/ha) than others except V_1I_1 (variety Shubhra and irrigation at 30 DAS). The interaction effects DxI and DxVxI were not found upto the significant level (table-23(c)).

Table-23(a): Effect of different treatments on total produce (Grain+Stover) q/ha.

Treatment	Total produce q/ha		
	1998	1999	Mean
Date of Sowing			
D_1	36.90	35.39	36.14
D_2	42.56	40.47	41.52
D_3	31.43	29.35	30.39
S.E.m±	0.50	0.54	0.37
C.D. (at 5%)	1.96	2.11	1.21
Variety			
V_1	27.22	25.65	26.43
V_2	48.50	45.45	46.98
V_3	32.77	31.02	31.89
V_4	39.35	38.15	38.75
S.E.m±	0.63	0.63	0.56
C.D. (at 5%)	1.77	1.78	1.57
No. of irrigation			
I_1	36.15	34.41	35.28
I_2	42.64	40.13	41.38
I_3	32.10	30.66	31.38
S.E.m±	0.54	0.55	0.48
C.D. (at 5%)	1.53	1.54	1.34

Table-23(b): Interaction effect of DxV on total produce.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	26.39	48.39	31.45	41.39
D_2	31.06	56.06	38.22	44.89
D_3	24.22	41.06	28.65	31.78
2nd Year (1999)				
D_1	25.10	47.28	29.22	39.97
D_2	29.41	53.29	36.35	42.82
D_3	22.44	35.78	27.50	31.66
Pooled				
D_1	25.74	47.83	30.33	40.68
D_2	30.23	54.68	37.28	43.86
D_3	23.33	38.42	28.08	31.72

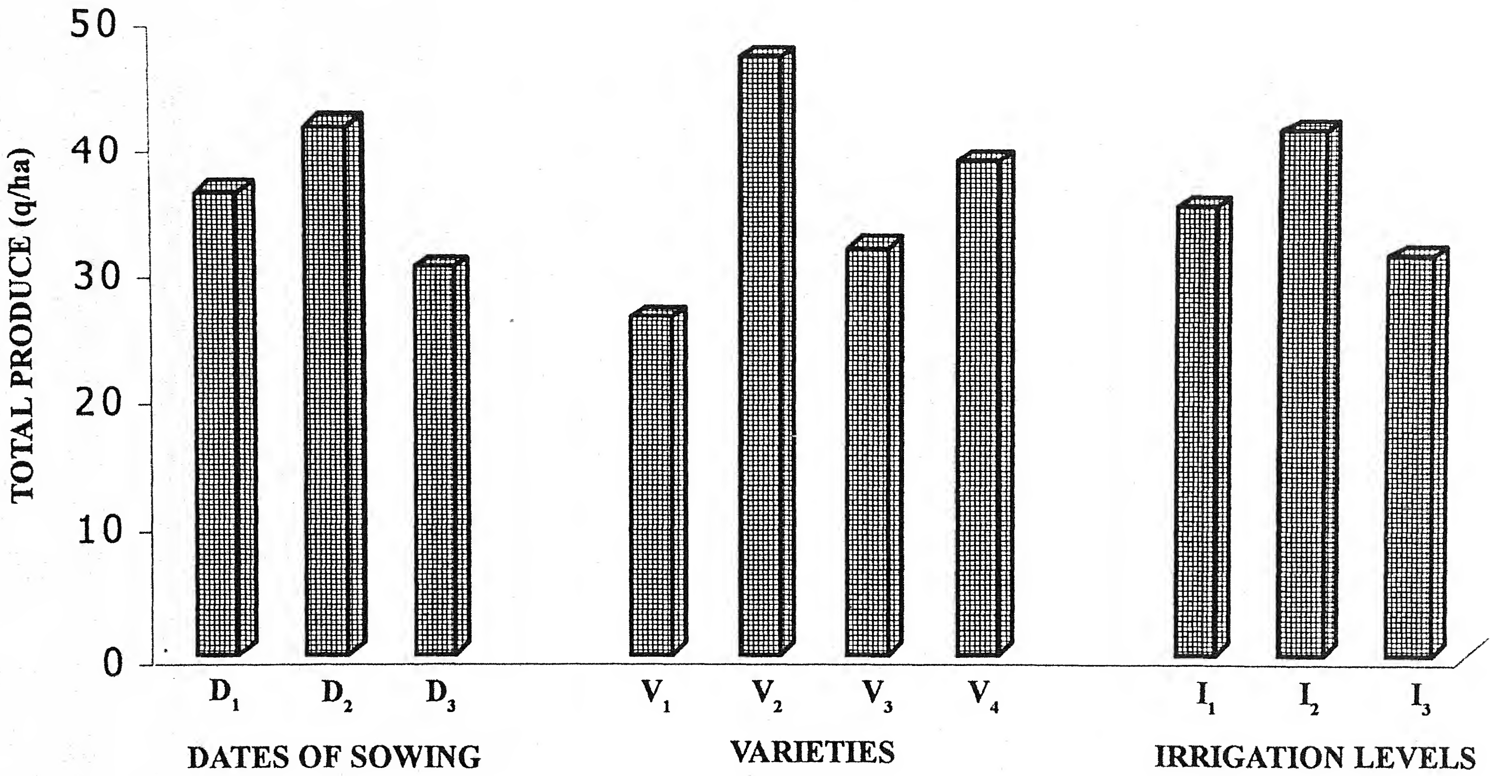
	S.E.m±	C.D. at 5%
1st Year (1998)	1.09	3.07
2nd Year (1999)	1.09	3.09
Pooled	0.77	2.16

Table-23(c): Interaction effect of VxI on total produce. (Year-1998)

Varieties	Irrigation levels		
	I_1	I_2	I_3
V_1	26.39	31.50	23.78
V_2	46.17	57.72	41.61
V_3	31.82	37.83	28.67
V_4	40.22	43.50	34.33

	VxI
S.E.m±	1.09
C.D. at 5%	3.07

FIG. 24: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON TOTAL PRODUCE



Seed yield (q/ha):

Seed yield q/ha of linseed in this trial as affected by dates of sowing varieties and irrigation levels is given in table 24(a) to 24(c), appendix 25 and depicted in fig. 25.

It is evident from table-24(a) that sowing dates affected the seed yield q/ha in both the years and in the mean of two years. In both the years D_2 (25 October sowing) recorded the maximum seed yield of 13.49 q/ha, and 12.35 q/ha in 1st and 2nd year respectively. This yield was 39.47% and 39.84% higher than D_3 (crop sown on 10 November) in first and 2nd year. It was also 19.2% and 15.68% higher than D_1 (10 October sowing) in both the years respectively. Yield of D_3 was also significantly lower in both the years by 20.47% and 24.22%. In the mean of two years, D_2 yielded 17.38% higher than D_1 and 39.63% (9.25 q/ha) than D_3 (sown on 10 November).

Table-24(a) further indicated that variety Neelum (V_2) significantly enhanced the seed yield (q/ha) as compared to other varieties. The maximum seed yield (14.96, 13.50 and 14.23 q/ha) was recorded in V_2 (Neelum) while minimum (8.65, 8.01 and 8.33 q/ha) in V_1 (Shubhra) which is significantly inferior than other varieties in both years as well as in pooled data of both years.

Seed yield q/ha was also significantly affected by number if irrigations applied to the crop. In first year I_2 (2 irrigations at 30 and 60 DAS) produced 13.49 q/ha, which was 35.98% higher than D_3 (3 irrigations at 30, 60 & 75 DAS) and 21.16% higher than D_1 (1 irrigation at 30 DAS). In 2nd year the increase was

31.0% and 20.39% higher than D_3 and D_1 by D_2. When the mean of two years was considered the similar trend was noticed and D_2 produced 35.70% higher than D_3 and 22.87% higher than D_1. In both the years and in the mean of two years D_1 also produced significantly higher seed yield by 22.88%, 10.62 and 12.83% respectively than D_3 level of irrigation.

Interaction between dates of sowing and varieties with regards to seed yield (q/ha) was found to be significant (table-24(b)), which indicated that variety V_2 (Neelum) significantly enhanced the seed yield as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest seed yield which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum seed yield of 17.44, 15.72 and 16.58 q/ha was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum seed yield of 7.45, 6.81 and 7.13 q/ha was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively.

Interaction effect of VxI on seed yield (q/ha) during 1st year 1998 was found significant. The treatment combination V_2I_2 (variety Neelum and irrigation at 30 and 60 DAS) significantly produced maximum seed yield (18.01 q/ha) as compared to all other treatment combinations. While treatment combination V_1I_3 (variety Shubhra and irrigation at 30, 60 and 75 DAS)) recorded significantly minimum seed yield (7.66 q/ha) than all other treatment combinations. The

interaction effects DxI and DxVxI were not found upto the significant level (table-24(c)).

Table-24(a): Effect of different treatments on seed yield q/ha.

Treatment	Seed yield (q/ha)		
	1998	1999	Pooled
Date of Sowing			
D_1	11.65	10.97	11.31
D_2	13.49	12.35	12.92
D_3	9.67	8.83	9.25
S.E.m±	0.19	0.20	0.14
C.D. (at 5%)	0.76	0.80	0.46
Variety			
V_1	8.65	8.01	8.33
V_2	14.96	13.50	14.23
V_3	10.24	9.46	9.85
V_4	12.55	11.90	12.22
S.E.m±	0.20	0.17	0.13
C.D. (at 5%)	0.56	0.48	0.36
No. of irrigation			
I_1	11.39	10.41	10.90
I_2	13.49	12.33	13.11
I_3	9.92	9.41	9.66
S.E.m±	0.17	0.15	0.11
C.D. (at 5%)	0.49	0.41	0.31

Table-24(b): Interaction effect of DxV on seed yield q/ha.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	8.51	15.10	10.00	12.98
D_2	9.99	17.44	11.95	14.56
D_3	7.45	12.34	8.78	10.11
2nd Year (1999)				
D_1	8.18	14.00	9.26	12.45
D_2	9.03	15.72	10.96	13.70
D_3	6.81	10.77	8.17	9.56
Pooled				
D_1	8.34	14.55	9.63	12.71
D_2	9.51	16.58	11.46	14.13
D_3	7.13	11.56	8.47	9.84

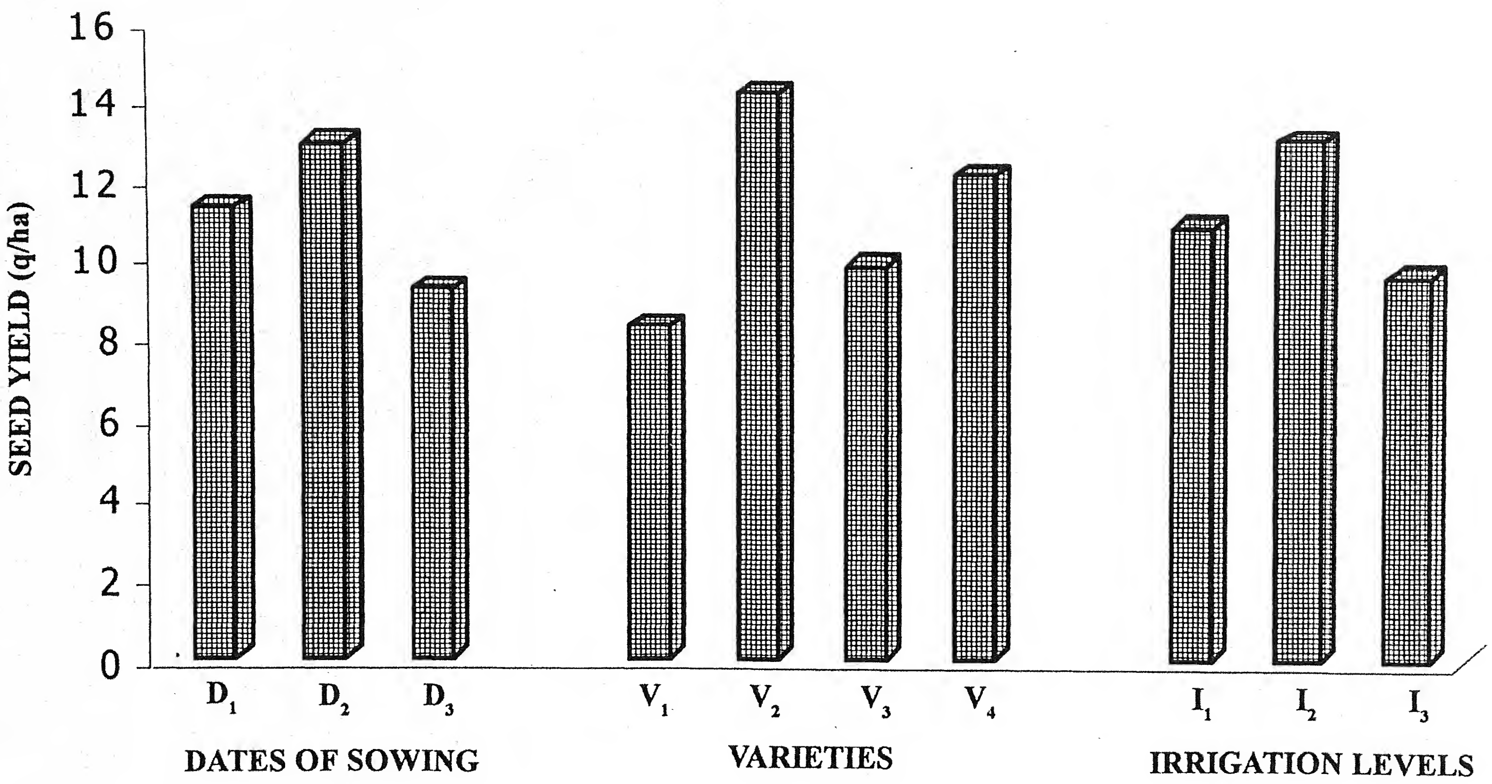
	S.E.m±	C.D. at 5%
1st Year (1998)	0.35	0.98
2nd Year (1999)	0.29	0.80
Pooled	0.23	0.64

Table-24(c): Interaction effect of VxI on seed yield q/ha. (Year-1998)

Varieties	Irrigation levels		
	I_1	I_2	I_3
V_1	8.44	9.84	7.66
V_2	14.22	18.01	12.66
V_3	9.94	11.95	8.83
V_4	12.95	14.17	10.54

	VxI
S.E.m±	0.35
C.D. at 5%	0.98

FIG. 25: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON SEED YIELD



Stover yield (q/ha):

Stover yield q/ha as affected by date of sowing varieties and number of irrigation is given in table 25(a) to 25(b), appendix 27 and depicted in fig. 26.

From table-25(a) it can be seen that stover yield was significantly affected by the date of sowing in both the years. D_2 (sown on 25 October) recorded maximum weight of stover than D_1 (sown on 10 October), which produced significantly higher stover yield than D_3 (sown on 10 November). Similar trend was also noticed in 2nd year and in the pooled data. D_2 recorded 51.83%, 36.43% and 23.09% higher yield then D_1 in 1st, 2nd year and in the pooled data while D_1 recorded 15.83%, 22.90% & 10% higher stover yield over D_3 (10 November sowing) which produced 20.96 q/ha, 20.50 q/ha and 20.73 q/ha in 1st, 2nd and in the mean of two years.

Stover yield in different varieties was also affected significantly. In both the years V_2 (Neelum) produced 32.34 q/ha, 31.97 q/ha and 32.15 q/ha in 1st, 2nd and in the mean of two years respectively. Significantly highest stover yield than all other varieties V_4 (Laxmi-27) was in 2nd order of production, V_3 (Sweta) 3rd and V_1 (Shubhra) recorded the lowest yield in both the years and in the pooled data.

Number of irrigations given to the linseed crop in the trial also affected significantly the stover yield in both the years and in the pooled data. Stover yield q/ha was significantly higher in I_2 level of irrigation. It was 28.42 q/ha, 27.80 q/ha

and 28.11 q/ha in 1st, 2nd and in the mean of two years, respectively, significantly higher than I_1 (one irrigation at 30 DAS), which recorded 24.67, 23.93 and 24.30 q/ha respectively in 1st, 2nd and in the mean of two years. I_1 was also found significantly superior than I_3 (3 irrigation at 30, 60 and 75 DAS) which recorded 22.13, 21.23 and 21.68 q/ha stover yield in 1st, 2nd and in the pooled data respectively.

Interaction between dates of sowing and varieties with regards to stover yield (q/ha) was found to be significant (table-25(b)), which indicated that variety V_2 (Neelum) significantly enhanced the stover yield as compared to other varieties sown at any dates in both the years as well as in pooled data of both years. However, variety V_1 (Shubhra) produced lowest stover yield which was significantly inferior to other varieties sown at any dates in the first year, second year and in the pooled data of both years. The maximum stover yield of 38.58, 37.55 and 38.07 q/ha was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum stover yield of 16.76, 15.61 and 16.19 q/ha was recorded from D_3V_1 (10 November sowing date and variety Shubhra) except D_1V_1 in the first year, second year and in pooled data of both years, respectively.

The interaction effects DxI, VxI and DxVxI were not found upto the significant level.

Table-25(a): Effect of different treatments on stover yield.

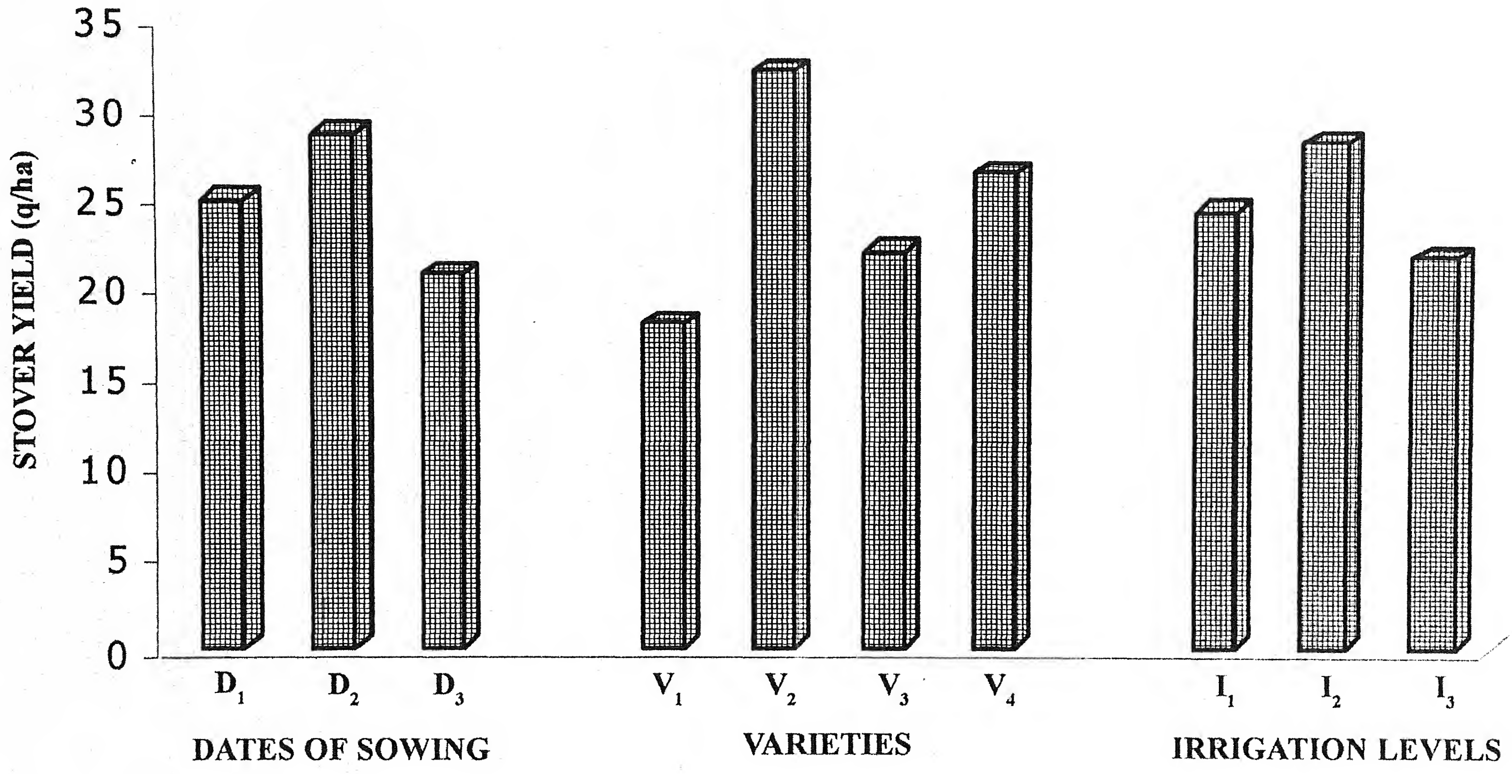
Treatment	Stover yield (q/ha)		
	1998	1999	Pooled
Date of Sowing			
D_1	25.24	24.36	24.80
D_2	29.01	28.09	28.55
D_3	20.96	20.50	20.73
S.E.m±	0.59	0.64	0.44
C.D. (at 5%)	2.33	2.51	1.43
Variety			
V_1	18.48	17.63	18.05
V_2	32.34	31.97	32.16
V_3	22.77	21.49	22.13
V_4	26.70	26.19	26.44
S.E.m±	0.39	0.48	0.32
C.D. (at 5%)	1.10	1.34	0.90
No. of irrigation			
I_1	24.67	23.93	24.30
I_2	28.42	27.80	28.11
I_3	22.13	21.23	21.68
S.E.m±	0.34	0.41	0.28
C.D. (at 5%)	0.95	1.16	0.78

Table-25(b): Interaction effect of DxV on stover yield q/ha.

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
<u>1st Year (1998)</u>				
D_1	17.76	33.18	21.86	28.17
D_2	20.92	38.58	26.25	30.29
D_3	16.76	25.26	20.20	21.65
<u>2nd Year (1999)</u>				
D_1	16.94	33.38	19.76	27.39
D_2	20.33	37.55	25.38	29.10
D_3	15.61	24.99	19.33	22.08
<u>Pooled</u>				
D_1	17.35	33.28	20.81	27.78
D_2	20.63	38.07	25.81	29.70
D_3	16.19	25.13	19.76	21.86

	S.E.m±	C.D. at 5%
1st Year (1998)	0.67	1.90
2nd Year (1999)	0.82	2.32
Pooled	0.56	1.56

FIG. 26: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON STOVER YIELD



Oil content:

The oil content percent in linseed as in influenced by dates of sowing varieties and levels of irrigation in both the years and mean of two years is given in table-26, appendix 28 and depicted in figure 27.

From the table-26 it is clear that dates of sowing had significantly affected oil content per cent in both the years and also the affect is evident in mean of two years. Significantly higher oil content per cent was recorded in I_2 (2 irrigations at 30 and 60 DAS) than I_1 and I_3 (3 irrigations at 30, 60 and 75 DAS) were at par in first year. In 2^{nd} year the same trend was noticed. In the mean of two years D_1 & D_3 are par while D_2 is significant than these dates of sowing.

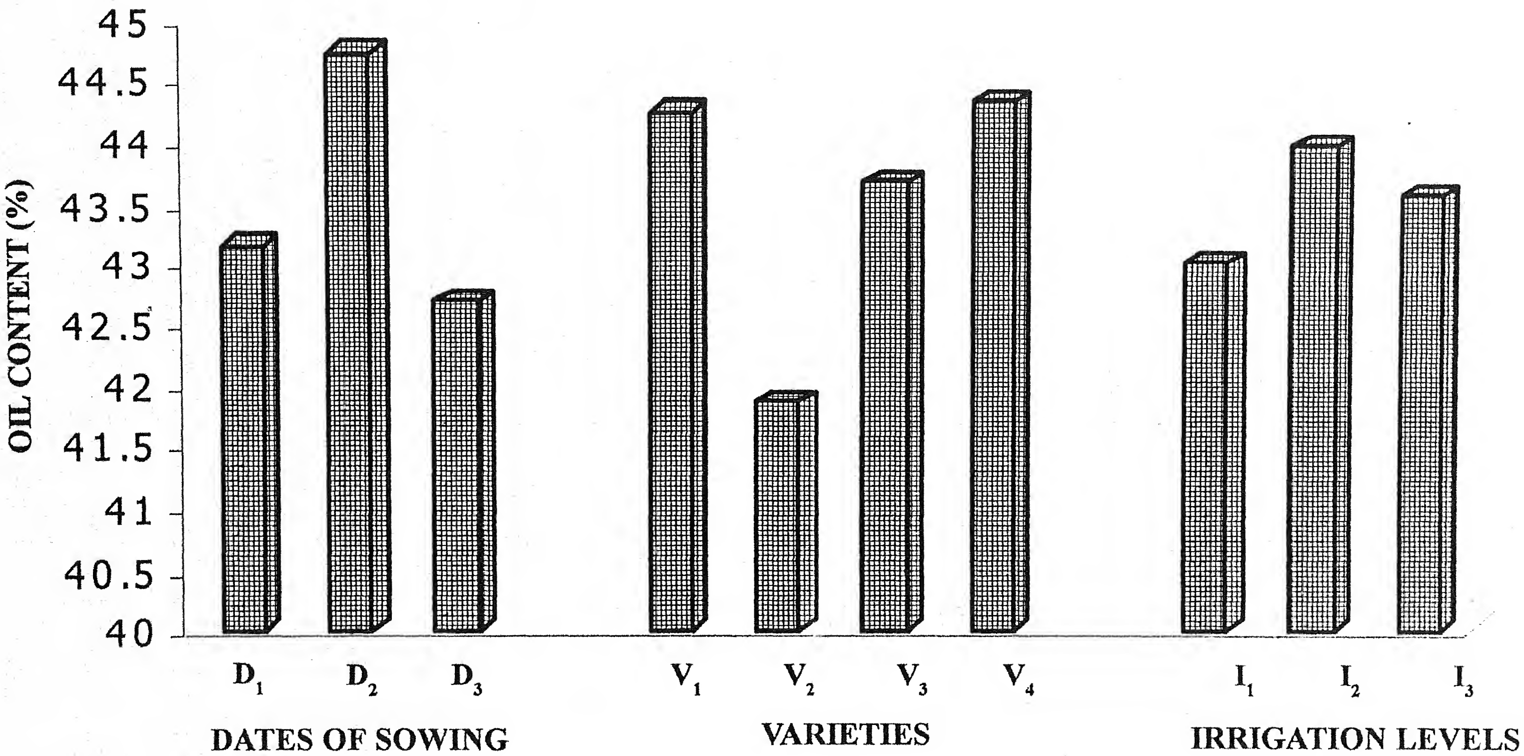
The above table indicated that varieties had significantly affected oil content per cent in both the years and also the effect is evident in mean of two years. V_1, V_3 and V_4 (Shubhra, Sweta and Laxmi-27) are at par but significantly superior in percent - oil content than V_2 (Neelum) in both the years and in the mean of two years or in pooled data.

Percent oil content was not affected significantly due to number of irrigations in both the years and in the mean of two years. However, V_4 (Laxmi-27) recorded the higher percent oil content followed by V_1 (Shubhra), and V_3 (Sweta) than V_2 (Neelum) in both the years and in the mean of two years.

Table-26: Oil content per cent in linseed influences by dates of sowing, varieties and level of irrigations.

Treatment	Oil content per cent		
	1998	1999	Pooled
Date of Sowing			
D_1	43.28	43.01	43.14
D_2	44.95	44.47	44.71
D_3	42.76	42.63	42.69
S.E.m±	0.30	0.23	0.19
C.D. (at 5%)	1.17	0.89	0.62
Variety			
V_1	44.41	44.05	44.23
V_2	41.96	41.73	41.84
V_3	43.78	43.55	43.66
V_4	44.51	44.15	44.33
S.E.m±	0.42	0.41	0.29
C.D. (at 5%)	1.18	1.17	0.81
No. of irrigation			
I_1	43.16	42.88	43.02
I_2	44.09	43.86	43.97
I_3	43.74	43.37	43.55
S.E.m±	0.36	0.36	0.35
C.D. (at 5%)	NS	NS	NS

FIG. 27: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON OIL CONTENT



Oil (q/ha):

Oil (q/ha) as affected by date of sowing, varieties and irrigation frequencies, are given in table 27(a) to 27(c), appendix 29 and figure 28.

It is clear from table-27(a) that D_2 (25 October sowing) produced the maximum oil (q/ha) than D_1 (10 October sowing) and D_3 (10 November sowing). Among the D_2, D_1 and D_3 dates of sowing the differences were significant in oil (q/ha). The similar trend was noticed in both the years and mean of the two years.

The difference in oil (q/ha) was noticed significant among the four varieties of the trial. Significantly maximum oil (q/ha) was recorded in V_2 (Neelum), followed by V_4 (Laxmi-27) and V_3 (Sweta) than V_1 (Shubhra) in both the years and in the mean of two years.

Like date of sowing and varieties, frequency of irrigation has also affected oil (q/ha). Significant more oil (q/ha) was recorded in I_2 (2 irrigation at 30 and 60 DAS) followed by I_1 (irrigation at 30 DAS) and I_3 (3 irrigations at 30, 60 and 75 DAS) in both the years as well as in pooled data. The differences among the frequency of irrigation with respect of oil (q/ha) were also significant in both the years and in the mean of two years.

Interaction between dates of sowing and varieties with regards to oil (q/ha) was found to be significant (table-27(b)), which indicated that variety V_2 (Neelum) significantly enhanced the oil as compared to other varieties sown at any dates except D_1V_4 in both the years as well as in pooled data of both years.

However, variety V_1 (Shubhra) produced lowest oil which was significantly inferior to other varieties sown at any dates (except D_1V_3 in the second year) in the first year, second year and in the pooled data of both years. The maximum oil of 7.53, 6.76 and 7.14 q/ha was obtained in D_2V_2 (25 October sowing date and variety Neelum) while minimum oil of 3.22, 2.94 and 3.08 q/ha was recorded from D_3V_1 (10 November sowing date and variety Shubhra) in the first year, second year and in pooled data of both years, respectively.

Interaction effect of VxI on oil during 1st year 1998 was found significant (table-27(c)). The treatment combination V_2I_2 (variety Neelum and irrigation at 30 and 60 DAS) significantly produced maximum oil (7.66 q/ha) as compared to all other treatment combinations. While treatment combination V_1I_3 (variety Shubhra and irrigation at 30, 60 and 75 DAS)) recorded significantly minimum oil (3.44 q/ha) than others except V_1I_1 (variety Shubhra and irrigation at 30 DAS) and V_3I_3 (variety Sweta and irrigation at 30, 60 and 75 DAS)).

The interaction effects DxI and DxVxI were not found upto the significant level.

Table-27 (a): **Effect of different treatments on oil (q/ha).**

Treatment	Oil (q/ha)		
	1998	1999	Pooled
Date of Sowing			
D_1	5.02	4.70	4.86
D_2	6.03	5.47	5.75
D_3	4.12	3.75	3.93
S.E.m±	0.11	0.10	0.07
C.D. (at 5%)	0.43	0.40	0.24
Variety			
V_1	3.85	3.53	3.69
V_2	6.28	5.64	5.96
V_3	4.50	4.13	4.31
V_4	5.60	5.27	5.44
S.E.m±	0.11	0.08	0.07
C.D. (at 5%)	0.30	0.23	0.19
No. of irrigation			
I_1	4.91	4.46	4.68
I_2	5.94	5.39	5.67
I_3	4.32	4.08	4.20
S.E.m±	0.09	0.07	0.06
C.D. (at 5%)	0.26	0.20	0.16

Table-27(b): Interaction effect of DxV on oil (q/ha).

Dates of sowing	Varieties			
	V_1	V_2	V_3	V_4
1st Year (1998)				
D_1	3.73	6.17	4.35	5.80
D_2	4.60	7.53	5.35	6.64
D_3	3.22	5.14	3.78	4.35
2nd Year (1999)				
D_1	3.56	5.69	4.00	5.54
D_2	4.09	6.76	4.88	6.15
D_3	2.94	4.47	3.50	4.10
Pooled				
D_1	3.64	5.93	4.17	5.67
D_2	4.34	7.14	5.11	6.39
D_3	3.08	4.81	3.64	4.18

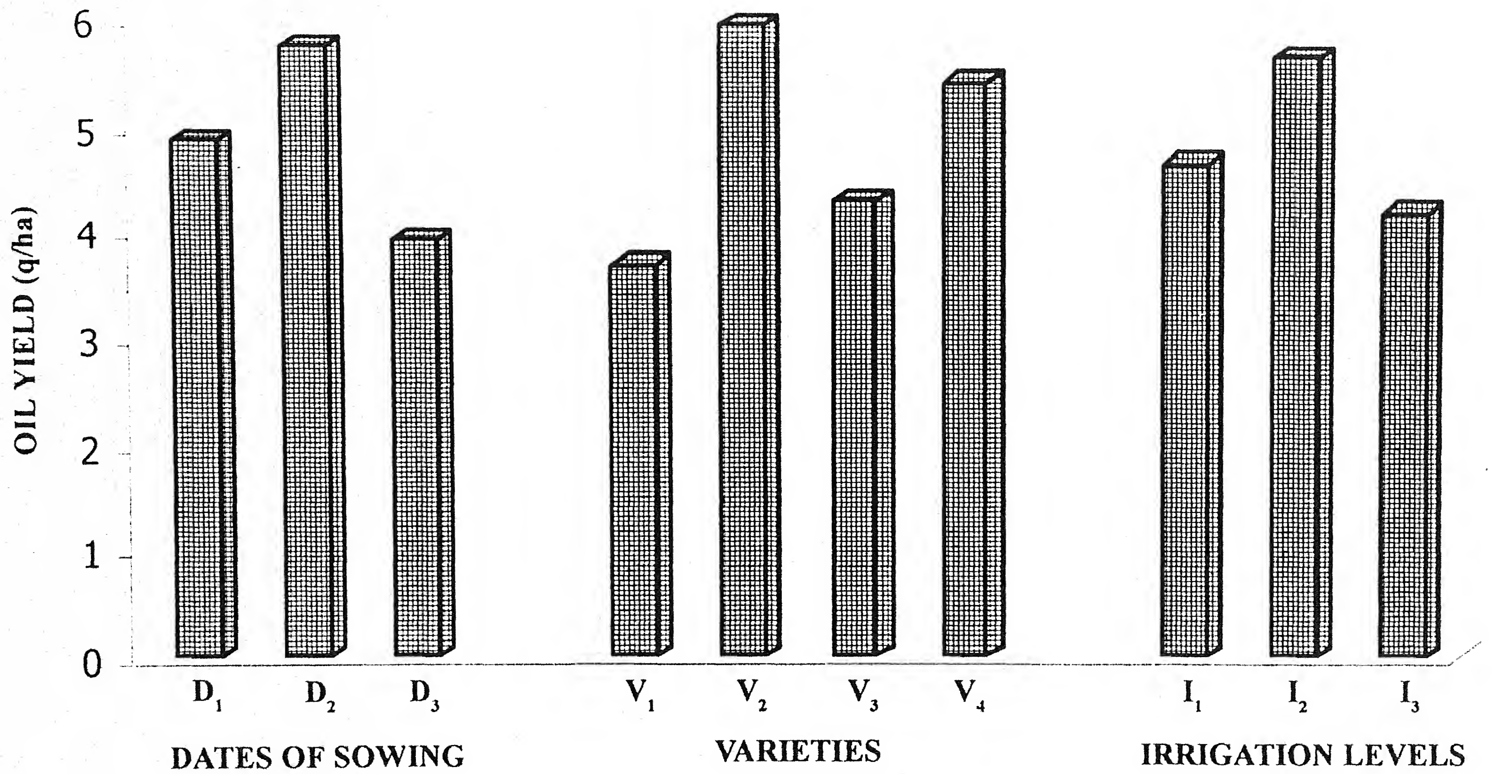
	S.E.m±	C.D. at 5%
1st Year (1998)	0.17	0.52
2nd Year (1999)	0.14	0.46
Pooled	0.12	0.33

Table-27(c): Interaction effect of VxI on oil (q/ha). (Year-1998)

Varieties	Irrigation levels		
	I_1	I_2	I_3
V_1	3.71	4.40	3.44
V_2	5.90	7.66	5.28
V_3	4.32	5.30	3.87
V_4	5.71	6.39	4.70

	VxI
S.E.m±	0.17
C.D. at 5%	0.52

FIG. 28: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON OIL YIELD



Protein:

Protein per cent in seed as affected by different dates of sowing, varieties and number of irrigations is given in table-28, appendix 30 and depicted in fig. 29.

Table-28: Effect of different treatments on protein per cent in linseed.

Treatment	Protein content percent in linseed		
	1998	1999	Pooled
Date of Sowing			
D_1	13.47	13.36	13.41
D_2	14.31	14.18	14.24
D_3	13.11	12.99	13.05
S.E.m±	0.15	0.20	0.12
C.D. (at 5%)	0.57	0.77	0.39
Variety			
V_1	12.69	12.57	12.63
V_2	16.08	15.99	16.03
V_3	12.00	11.86	11.93
V_4	13.75	13.63	13.69
S.E.m±	0.31	0.34	0.23
C.D. (at 5%)	0.86	0.96	0.64
No. of irrigation			
I_1	13.36	13.22	13.29
I_2	13.90	13.80	13.85
I_3	13.63	13.52	13.58
S.E.m±	0.26	0.30	0.20
C.D. (at 5%)	NS	NS	NS

From the above table-28, it is clear that date of sowing affected the protein per cent in seeds. Significantly higher protein per cent was recorded by D_2 (25 October sowing) followed by D_1 (10 October sowing) and the minimum protein per cent was found in D_3 (10 November sowing). This trend was found in both the years and in pooled data.

Economics:

During the introduction and cultivation of a crop variety it is essential to find out whether it is suitable economically for the area. Similarly during an experiment, it is also necessary to find which of the treatment is enhancing the net income/hectare and which of them reduce it due to high cost of cultivation. In order to find out this, first the cost of cultivation is given in table-29 and economics of cultivation of linseed crop as affected by date of sowing, varieties and levels of nitrogen in table-30.

FIG. 29: EFFECT OF DATES OF SOWING, VARIETIES AND IRRIGATION LEVELS ON PROTEIN CONTENT

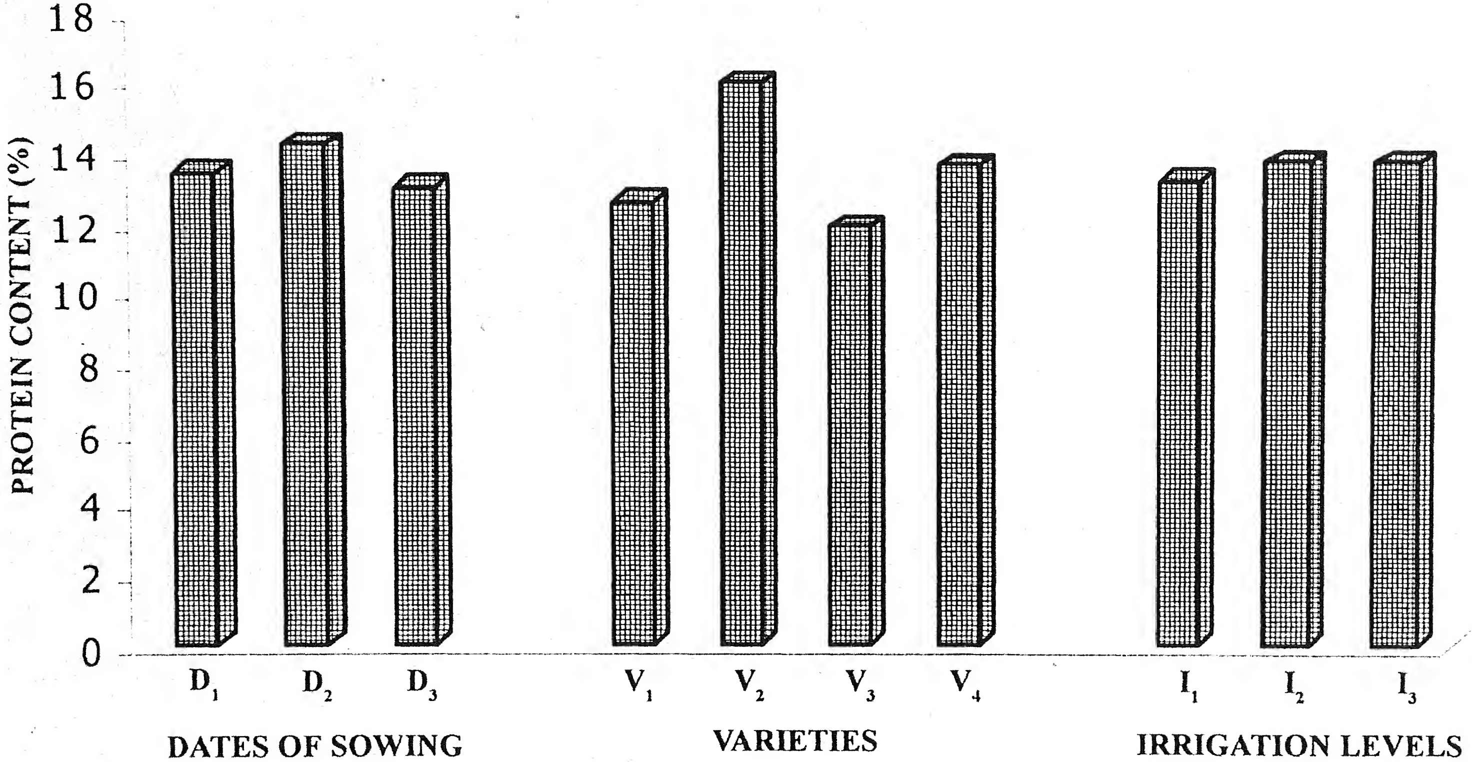


Table-29: Showing common cost of cultivation (Rs/ha).

S. No.	Particulars of operation	Cost Rs/ha	
		1998-99	1999-2000
1	**Field Preparation**		
	(a) One ploughing by soil turning pairs (3 pairs of bullock and 3 labours for one day)	360.00	360.00
	(b) Two harrowing with planking (4 pairs of bullock and 4 labours for one days)	460.00	460.00
2	**Layout, ridge, irrigation etc. making (4 labours for one day)**	500.00	500.00
3	**Seed and sowing**		
	(a) Cost of seed 80 kg/ha @ Rs 20/kg	1600.00	1600.00
	(b) Cost of sowing (2 pairs of bullocks & 4 labours for one day)	340.00	340.00
4	**Fertilizers**		
	(a) Cost of 60 kg N + 30 kg P_2O_5 + 30 kg K_2O/ha (@ Rs. 8.70/kg N, Rs 15.63/ kg P_2O_5 and Rs. 8.33/kg K_2O)	1240.90	1240.90
	(b) Fertilizer application cost (2 labours for 1 day)	100.00	100.00
	(c) Top dressing of Urea 30 DAS (1 labour)	50.0	50.0
5	**Weeding and thinning** (15 women labours for one day)	600.00	600.0
6	**Plant Protection**		
	(a) Insecticide cost (500 ml Endosulphan @ Rs 250 per liter)	125.00	125.00
	(b) Insecticide application charges (4 labours for 1 day)	200.00	200.00
7	**Land revenue tax during the crop period**	2500.00	2500.00
8	**Miscellaneous**	150.00	150.00
9	**Interest on working capital @ 7% during crop period**	577.00	577.00
Total cost of cultivation excluding harvesting & threshing charges		**8822.90**	**8822.90**

Table-30: **Charges for harvesting, threshing, winnowing and packing.**

S. No.	Particulars of operation	Cost Rs/ha	
		1998-99	1999-2000
1	Cost of harvesting (16 labours for 1 day)	640.00	640.00
2	Bundle making, loading and transportation to threshing floor (2 bullock carts and 6 labours for 1 day)	450.00	450.00
3.	Threshing (15 labours for 1 day)	750.00	750.00
4.	Winnowing & packaging charge (15 labours for 1 day)	400.00	400.00
5.	Miscellaneous charges including sundry expenses	317.30	317.30
Total harvesting, threshing, winnowing and packaging charges		**2496.30**	**2496.30**
Market price of linseed Q/ha		**1580.00**	**1565.00**

Total irrigation charges for 1st irrigation Rs. 428/ha

Total irrigation charges for 2nd irrigation Rs. 791/ha

Total irrigation charges for 3rd irrigation Rs. 1219/ha

Labour charges Male Rs. 50/day

Labour charges Female Rs. 40/day

Table-31: Cost of cultivation, gross income, net income and B/C ratio in 1998-99 year

S. No.	Treatment combination	Seed yield (q/ha)	Cost of harvesting (Rs/ha)	Cost of irrigation (Rs/ha)	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B/C ratio
1	$D_1V_1I_1$	8.17	994.86	428.00	10245.76	12908.60	2662.84	0.26
2	$D_1V_1I_2$	9.87	1201.87	791.80	10744.57	15594.60	4850.03	0.45
3	$D_1V_1I_3$	7.50	913.28	1219.80	10955.98	11850.00	894.02	0.08
4	$D_1V_2I_1$	14.50	1765.67	428.00	11016.57	22910.00	11893.43	1.08
5	$D_1V_2I_2$	17.67	2151.68	791.80	11766.38	27918.60	16152.22	1.37
6	$D_1V_2I_3$	13.17	1603.71	1219.80	11646.41	20808.60	9162.19	0.79
7	$D_1V_3I_1$	9.67	1177.52	428.00	10428.42	15278.60	4850.18	0.47
8	$D_1V_3I_2$	11.50	1400.36	791.80	11015.06	18170.00	7154.94	0.65
9	$D_1V_3I_3$	8.50	1035.05	1219.80	11077.75	13430.00	2352.25	0.21
10	$D_1V_4I_1$	13.33	1623.20	428.00	10874.10	21061.40	10187.30	094
11	$D_1V_4I_2$	15.17	1847.25	791.80	11461.95	23968.60	12506.65	1.09
12	$D_1V_4I_3$	10.67	1299.29	1219.80	11341.99	16858.60	5516.16	0.49
13	$D_2V_1I_1$	9.67	1177.52	428.00	10428.42	15278.60	4850.18	047
14	$D_2V_1I_2$	11.50	1400.36	791.80	11015.06	18170.00	7154.94	0.65
15	$D_2V_1I_3$	8.80	1071.58	1219.80	11114.28	13940.00	2789.72	0.25
16	$D_2V_2I_1$	16.67	2029.90	428.00	11280.80	26338.60	15057.80	1.33
17	$D_2V_2I_2$	20.50	2496.20	791.80	12111.00	32390.00	20279.00	1.67
18	$D_2V_2I_3$	15.17	1847.25	1219.80	11889.95	23968.60	12078.65	1.02

Table- 32 : Cost of cultivation, gross income, net income and B/C ratio i 1999-2000 year.

S.N.	Treatment combination	Seed yield (q/ha)	Cost of investing (Rs/ha)	Cost of irrigation (Rs/ha)	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B/C ratio
1	$D_1V_1I_1$	7.80	1052.53	428.00	10303.43	12207.00	1903.57	0.19
2	$D_1V_1I_2$	9.33	1258.99	791.80	10903.69	14601.45	3697.76	0.34
3	$D_1V_1I_3$	7.40	998.56	1219.80	11041.26	11581.00	539.74	0.05
4	$D_1V_2I_1$	13.50	1821.69	428.00	11072.59	21127.50	10054.91	0.91
5	$D_1V_2I_2$	16.13	2176.50	791.80	11719.28	25343.45	13524.17	1.15
6	$D_1V_2I_3$	12.37	1669.21	1219.80	11711.91	19359.05	7647.14	0.65
7	$D_1V_3I_1$	8.85	1194.22	428.00	10445.12	13850.25	3405.13	0.33
8	$D_1V_3I_2$	11.10	1497.83	791.80	11112.53	17371.50	6258.97	0.56
9	$D_1V_3I_3$	8.17	1102.46	1219.80	11145.16	12786.05	1640.89	0.15
10	$D_1V_4I_1$	12.67	1709.69	428.00	10960.59	19828.55	8867.96	089
11	$D_1V_4I_2$	14.85	2003.86	791.80	11618.56	23240.25	11621.69	1.00
12	$D_1V_4I_3$	10.17	1372.34	1219.80	11415.04	15916.05	4501.01	0.39
13	$D_2V_1I_1$	8.67	1169.93	428.00	10420.83	12568.55	3147.72	0.30
14	$D_2V_1I_2$	10.33	1393.93	791.80	11008.63	16166.45	5157.82	0.47
15	$D_2V_1I_3$	8.10	1093.01	1219.80	11135.71	12676.50	1540.79	0.14
16	$D_2V_2I_1$	15.67	2114.57	428.00	11365.41	24523.55	13158.14	1.16
17	$D_2V_2I_2$	17.33	2338.51	791.80	11953.21	27121.45	15168.24	1.27
18	$D_2V_2I_3$	14.17	1912.10	1219.80	11954.80	22176.05	10222.25	0.86

SN o.	Treatment combination	Seed yield (q/ha)	Cost of investi-ng (Rs/ha)	Cost of irrigation (Rs/ha)	Total cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	B/C ratio
19	$D_2V_3I_1$	10.33	1393.93	428.00	10644.83	16166.45	5521.62	0.52
20	$D_2V_3I_2$	12.87	1736.68	791.80	11351.38	20141.55	8790.17	0.77
21	$D_2V_3I_3$	9.67	1304.87	1219.80	11347.57	15133.55	3785.98	0.33
22	$D_2V_4I_1$	13.80	1862.17	428.00	11113.07	21597.00	10483.93	0.94
23	$D_2V_4I_2$	15.17	2047.04	791.80	11661.74	23741.05	12079.31	1.04
24	$D_2V_4I_3$	12.13	1636.82	1219.00	11679.52	18983.45	7303.93	0.63
25	$D_3V_1I_1$	6.50	877.11	428.00	10128.01	10172.50	44.49	0.004
26	$D_3V_1I_2$	7.80	1052.53	791.80	10667.23	12207.00	1539.77	0.14
27	$D_3V_1I_3$	6.13	827.18	1219.80	10869.88	9593.45	-127.43	-
28	$D_3V_2I_1$	10.33	1393.93	428.00	10644.83	16166.45	5521.62	0.52
29	$D_3V_2I_2$	12.87	1736.68	791.80	11351.38	20141.55	8790.17	0.77
30	$D_3V_2I_3$	9.13	1231.09	1219.80	11273.79	14288.45	3014.66	0.27
31	$D_3V_3I_1$	8.00	1079.52	428.00	10330.42	12520.00	2189.58	0.21
32	$D_3V_3I_2$	9.33	1258.99	791.80	10873.69	14601.45	3727.76	0.34
33	$D_3V_3I_3$	7.17	967.52	1219.80	11010.22	11221.05	210.83	0.02
34	$D_3V_4I_1$	9.50	1281.93	428.00	10532.83	14867.50	4334.67	0.41
35	$D_3V_4I_2$	10.85	14643.10	791.80	11078.80	16980.25	5901.45	0.53
36	$D_3V_4I_3$	8.33	1124.05	1219.80	11166.75	13036.45	1069.70	0.17

On perusal of table –31 & 32 it is evident that highest B:C rato (benefit Cost ratio) and net return was received as in following treatments n year 1998 and 1999.

Table- 33. Net return per hectare in the year 1998 and 1999.

1998		1999	
Treatment	**Net return/ha (Rs.)**	**Treatment**	**Net return/ha (Rs.)**
$D_2V_2I_2$	20279.00	$D_2V_2I_2$	15168.24
$D_1V_2I_2$	16152.00	$D_1V_2I_1$	13524.00
$D_2V_2I_1$	15057.80	$D_2V_2I_1$	15057.80
$D_2V_4I_3$	139.3.91	$D_2V_4I_2$	12678.00
$D_3V_2I_2$	13498.25	$D_1V_4I_2$	11621.69
$D_1V_4I_2$	12506.65	$D_2V_4I_2$	10483.00
$D_2V_2I_3$	12078.65	$D_2V_2I_3$	10221.00
$D_1V_2I_1$	11893.43	$D_1V_2I_1$	10054.91
$D_1V_4I_2$	10187.30	$D_1V_2I_1$	10054.91
$D_1V_4I_2$	10187.30	$D_1V_4I_2$	8867.96

Out of 4 varieties of including in the trial only V_2 (Neelum) and V_4 (Laxmi-27) had produced higher net return than remaining V_1 (Shubhra) and V_3 (Sweta) varieties. This may be due to their good genetical character to produce higher yield. As regards the date of sowing D_2 (25th October sowing) followed by D_1 (10th October sowing) had the higher ner return/ha. D_3 (10th November sowing) has also revealed higher net return with V_2 (Neelum) at I_2 (irrigation 30 DAS). Highest net return/ha was recorded in I_2 (irrigation at 30 & 60 DAS) level of irrigation followed by I_1 (irrigation at 30 DAS) while in two cases I_3 (3 irrigations at 30, 60 and 75 DAS) level also produced higher net return/ha.

Response curve:

Quadratic response curve $Y=a+bX-cX^2$ was fitted for various treatments and are given in table-34.

Table-34: Equation for filling the response curve for dates of sowing and number of irrigations as influenced by linseed varieties.

Response curve for	Year	Response
(A) Dates of sowing (ignoring other factors)	1988	$Y=4.09+10.33X-2.83X^2$
	1999	$Y=4.59+8.73X-2.45X^2$
Dates of sowing as influenced by different linseed varieties		
(1) Shubhra	1988	$Y=2.99+7.51X-2.01X^2$
	1999	$Y=4.35+5.46X-1.53X^2$
(2) Neelum	1998	$Y=5.29+13.50X-3.72X^2$
	1999	$Y=5.59+11.72X-3.34X^2$
(3) Sweta	1998	$Y=2.95+9.63X-2.56X^2$
	1999	$Y=3.07+8.44X-2.25X^2$
(4) Laxmi-27	1998	$Y=5.49+9.99X-2.86X^2$
	1999	$Y=5.80+9.33X-2.69X^2$
(B) No. of irrigation (ignoring other factors)	1998	$Y=3.58+10.61X-2.84X^2$
	1999	$Y=3.69+9.18X-2.42X^2$
No. of irrigation as influenced by different linseed varieties		
(1) Shubhra	1988	$Y=3.49+6.77X-1.79X^2$
(2) Neelum	1998	$Y=1.31+17.50X-4.57X^2$
(3) Sweta	1998	$Y=2.83+9.71X-2.57X^2$
(4) Laxmi-27	1998	$Y=6.79+8.50X-2.43X^2$

All the linear and quadratic components were found significant. On the basis of quadratic equations the following conclusions were made:

1. The rate of increase in linseed yield fell off with the delay in sowing and higher number of irrigations (ignoring other factors).
2. Same trend was also observed for both factors (date of sowing and number of irrigation) for each linseed variety.

DISCUSSION

CHAPTER-V
DISCUSSION

Cultivation of linseed is very common in Bundelkhand region of Uttar Pradesh and to improve the production and productivity of this crop, four high yielding varieties are introduced in the region. In order to find out the suitability of high yielding linseed varieties for this region, performance of each variety under different conditions is to be studied. With this view experiment was conducted for two years with Shubhra, Neelum, Sweta and Laxmi-27 varieties of linseed, under three dates of sowing (10 October, 25 October and 10 November) and three levels of irrigation (one at 30 days after sowing, 2 at 30 and 60 days after sowing and 3 irrigations at 30, 60 and 75 days after sowing).

On the basis of the findings, attempt has been made in the chapter to explain the possible reasons of variability obtained due to different treatments. The results have been discussed in the light of the literature available for the different parameters in the study.

Effect of date of sowing:

Effect of date of sowing on the plant population though had no significant difference in both the years and in the pooled data. However in first year (D_2) 25 October sowing recorded higher plant population in first year and in the pooled data and in 2^{nd} year the plant population was almost similar in the three dates of sowing. Prevalence of higher mean and maximum temperature coupled with

favourable relative humidity and other environmental conditions prevailing during these dates of sowing in both the years almost similar type of plant population. Similar observations were reported by Sen and Chakaravarty (1994) and Tomar (1997) due to temperature and main environmental factor governing all elementary physiological process of plant. Fresh weight of linseed plants 30 days after sowing were not significantly different, however, crop sown on 25 October had higher fresh weight in both the years and in the pooled data due to reasons given above. Fresh weight recorded at 60, 90 days after sowing and at harvest was found significantly higher in D_2 (25 October sowing) followed by D_1 (10 October sowing). Both the dates had significantly higher fresh weight of plants than D_3 (10 November sowing). This may be attributed basically to the reason that crop sown on 10 October and 25 October received optimum environmental conditions for higher fresh weight, while delay in sowing (10 November) could not get favourable environmental conditions, hence the fresh weight of plants at all the above stages of record. Similar views were also reported by Lander (1934), Smith (1946) and Mullar (1952). According to them temperature controls the growth period of the oilseed crops considerably according to the duration of the crop.

Dry weight of plant was recorded at 30, 60, 90 days after sowing and at harvest in both the years and then data of both the years were pooled. In this parameter also D_2 sowing date had

produced significantly more dry weight than D_1 (10 October sowing) and D_3 (10 November) sowing date at all the stages of record. Both D_2 and D_1 more duration for accumulating the weight. Moreover one more number of irrigation helped to gather more photosynthates in the plant. Mullar (1962), Henry and Danlay(1988), Singh(1991) Yadav and Yadav(1997) had also reported similar views.

The height of main shoot recorded at 30, 60 and 90 days after sowing was significantly affected due to date of sowing. In both the years and in the pooled data of two years at each stage the higher height was noticed in D_2 (25 October sowing). It was significantly superior to D3 but was at par with D_1. This may be due to the fact that the crop sown in D_2 and D_1 dates(10 October and 25 October) got sufficient more time than D_3 sowing date (10 November) for proper vegetative growth and development as reported by Sen Chakravarty(1944), Mullar(1952), Majumdar(1962), Tomar(1998) and Singh *et al.*(2001).

Number of primary branches, secondary branches and tertiary branches parameters are very important for linseed yield. In both the years and in the pooled data of two years, date of sowing recorded distinct influence on growth and development of the above mentioned three parameters. In D_2 date of sowing(25 October sowing) significantly produced higher number of primary, secondary and tertiary branches in the crop than D_1 and D_3 dates of

sowing. However D_1 date of sowing had also recorded significantly higher number of these parameters then D_3(10 November sowing). Low temperature in November sown crop at early stage resulted in low dry matter accumulation which delayed and reduced number of these parameters while October sown crop coincided with congenial temperature which had affected all elementary physiological process in the plant resulted in more number of primary, secondary and tertiary branches/plant as supported by SenGupta and Chakravarty (1944), Mullar(1952), Garg(1961), Lahiri(1964), Critchfeild(1966) and Saini(1972), Kumar and Shastry(1984).

Among the yield attributing characters in linseed, number of seeds and weight of capsules/plant and number of seeds and weight of seeds/capsule and weight of seeds/plant are the most responsive yield components. The capsules which produce seeds in linseed are produced in cycles because linseed has distinct flowering period separated by brief resting period date of sowing of linseed plant is important in determining the number of cycles and number of flowers produced in each cycle(Yarmanos and Worker, 1964). The crop sown in D_1 and D_2 that is on 10 October and 25 October might have more cycles due to the long duration by early sowing than D_3(10 November sowing) recorded significantly higher number of above yield attributes. Crop sown on D_1 and D_2 dates of October clubbed with suitable irrigation levels enhanced parameters i. e. number and weight of capsules, number and weight of

seeds/capsule and number of seeds/plant. This may also be attributed basically to the reason that crop sown 10 and 25 October each years also received optimum environmental conditions required for better crop growth and above yield attributing parameters. These finding are in agreement with those of Sethi and Sharma(1952), Garg(1961), Lahiri(1964), Aulak and Bahal(1989), Shrivastava(1990), Rajput Iet al.(1991), Mahapatra(1993), Rathore(1995) and Phalwan and Kapre(2002).

Date of sowing recorded distinct influence on biomass, seed and stover yield (q/ha). D_2 produced significantly more (biomass, seed and stover yield) than D_1which had also significantly higher values of these than D_3(10 November sowing). This may be the result of increase in dry matter and yield attributes of linseed crop sown in 10 and 25 October. Low temperature at vegetative and flowering stages might have caused slow growth and delayed phonological stages in November sown crop. This also resulted in poor development of all yield attributes of linseed crop. Hence November sown crop gave lower biomass, seed and stover yield of linseed. Saini(1972), Rai and Kumar(1978), Saran and Giri(1987), Rajput *et al.*(1991), Rathore(1995) have also expressed similar views. The above findings are also in agrrement with opinions of various scientist working at Kanpur, Palampur, Raipur and Nagpur during 1997-1999 as mentioned in Annual Report of AICORPO of 1997-98 and 1999-2000.

Evaluation of nutritional modifications in linseed grain, in addition to quantitative achievements(yield attributes and yield of seed and stover) is a necessary adjunct in relevance to the present investigation. There was a significantly difference in percent oil content in linseed seed due to date of sowing. In both the years the percent oil content was significantly higher in D_2 (25 October sowing) than D_1 (10 October sowing) which was also significantly superior than D_3 (10 November). Similarly trend was also noticed in the mean of two years. Lender (1934), Smith (1949), Majumdar (1962), Bisnoi and Singh (1979), Kumar and Shastry (1984), Ghosh and Chatterjee (1988) and Payasi *et al.*(1999)

Percent protein content in linseed was also significantly affected due to date of sowing. In both the years the protein content was also significantly affected and higher in D_2(25 October sowing) than D_1(10 October sowing). Similar trend was also found in the mean of two years. This may be due to the long duration that crop plant got in early sowing, and prevailing weather conditions. Along with these conditions, protein synthesis in plants continued for more time in early sown crop in D_1 and D_2 than D_3 sowing. These findings are supported by Majumdar(1962), Singh and Singh(1985), Ghosh and Chatterjee(1988) and Tomar(1998).

Effect of varieties:

Out of 29 parameters studied in the present investigation, significant differences were observed in almost all the parameters among varieties. This indicated that a good amount of variability is present in the genotypes of linseed included in this investigation. It shows that genotypes differed significantly in expressing their yield potential and yield components. Thus the performance of these genotypes with respect to yield attributes, yield, percent oil content and protein content is also different in Bundelkhand region of Uttar pradesh under similar set of environment conditions leader (1934), Smith (1949), Sethi and Sharma Garg (1961), Chauhan (1963), Tiwari et al. (1988) and Singh (1988) have also remarked similar views. Fresh weight of plants at 30, 60 and 90 days after sowing and at harvest was significantly higher in V_2 followed by V_3 and in some cases V_1 than other varieties in both the years and I the mean of two years. Similarly the dry weight of plan at 30, 60, 90 days after sowing and at harvest were significantly in V_2 (Neelum) followed by V_3 (Sweta) in both the years and in the mean of two years. Fresh weight and dry weight per plat in a crop depends upon their capacity to produce more photosynthesis and also to gain weight through better adoption of environment condition, uptake of nutrients from the soil. Due to these conditions, the fresh weight and dry weight / plant is related in linseed crop also. Similar views

were given by Jeshwani (1984). Height of main shoot at 30, 60, 90 days after sowing and at harvest were found significantly higher in V_2 (Neelum followed by V_1 (Shubhra) in both the year ad in the years and in the mean of two years. Both the above parameters were better in these varieties may be due to the genetic constitution and favorable environmental conditions prevailing during cultivation. Sen and Chakravarty (1944), Sethi ad Sharma (1952), Sigh (1988), Sharma (1999) ad Ram (1993) have also similar views about improved ad high yielding varieties over local traditional varieties.

Difference in number of primary, secondary and tertiary branches amongst the four varieties including in the investigation was present in both the years and in the mea of the two year. These three types of branches were significantly higher in V_2 (Neelum) and V_4 (Laxmi-27) in both the years and the mea of two years. The probable reason for the difference in primary, secondary branches and tertiary branches two above two varieties may be due to genetical quality and adoption under environmental conditions prevailing during the experimental period in southern western region of Bundelkhand of Uttar Pradesh. These findings are also in agreement with those of Jeswani (1984), Ojha (1985), Singh (1989) and Sharma (1999).

There was significant difference in number and weight of capsule/plant, number of seed and weight of seeds/capsule and

weight of seed / capsule and biomass / ha in both the years and in the mean of the two years. Number and weight of capsules per plant, number and weight of seeds per capsule were significantly higher in V_2 (Neelum) followed by V_4 (Laxmi-27) and V_3 (Sweta) in both the years and in the mea of two years. Similar trend in biomass was also seen in both the years and mean of two years. These parameters may be due to inherent quality of varieties, up take of nutrients and better utilization of environmental conditions. Both V_2 and V_4 surpassed in the above parameters than V_1 (Shubhra) and V_3 (Sweta). Tiwari et al. (1988), Ojha (1985), and Sharma (1999) expressed similar views.

Maturity of plats, 50 percent flowering and seed yield per plant (g), seed and stover yield quintal / hectare differences among varieties were found significant in both he years and in the mean of two years. These parameters were significantly higher in V_2 and V_4 (Neelum ad Laxmi-27). These types of yield depend upon nutrient up take, environment factors, comparative more umber of primary and secondary branches number of capsule / plant and seeds / capsule in V_2 (Neelum) and V_4 (Laxmi-27) varieties. Therefore the differences of yield / plant q / ha and stover yield q / ha is due to these above mentioned factors as reported by Jeswani (1984), ram (1993) and as per annual report of AICORP 1994-95 and 1995-96.

Percent oil content in different varieties also varied in the trial. In both the years significantly higher percent oil content was found in V_4 which was at par with V_1 (Shubhra) and V_3 (Sweta) and minimum was found in V_2 (Neelum), oil yield quintal/hectare was found higher in V_2 (Neelum) and V_4 (Laxmi-27) than V_1 (Shubhra) and V_3 (Sweta) due to yield of seed q/ha. Both percent oil content and oil yield q/ha may also the due to accumulation of more oil synthesizing constituents in these two varieties. Hence these varieties had more oil q/ha. Saran and Giri (1987), Singh *et al.* (1994) had also expressed similar views.

Percent protein content:

There was significant variation in percent protein content in the varieties in both the years and also the difference was found significant in the mean of two years. Significant higher protein content was found in V_2 (Neelum) than all other varieties. It is interesting to note that this variety had the lowest oil percent but the protein content is maximum. Protein synthesis is intimately connected with activities of the nucleic acid system and accumulation of certain amino acids and formation of protenious substances in a variety. Therefore, higher protein content in Neelum may be due to above factors, which may be more active in this variety as compared to the other varieties. Similar views were also expressed by Singh (1968), Rao (1982), Gupta (1987), Ghosh and Chatterjee (1988), Maiti and Chattopadhyaya (1988).

Effect of Irrigation :

Plant population is the number of plats required per unit area to achiever the highest yield. It depend on the nature of the crop and on its environment. This number cannot be too small, or it can be too large. Maximum exploitation of the factors needed for growth is achieved only when the plant population exercises maximum pressure o all the production factors provided there is no moisture stress to the crop. In this trial the plant population in both the years was not affected significantly due to umber of irrigation. However in both the years, thought the difference in plant population was not significant even then two irrigation given 30 and 60 days after sowing had the maximum number of plant population. Howard and Khan (1924). Sethi and Sharma (1952), Garg (1961), Guan and Zhangto (1987), Singh (1989), Josder / et al. (1979) have also advocated the need of two irrigations in the crop.

Fresh ad dry weight of plants were also affected due to irrigation numbers. Fresh weight at 30 days after sowing was significantly affected in 2nd year only. However higher fresh weight was found in 2 irrigation (at 30 and 60 days after sowing) followed by 3 irrigation (at 30, 60 and 90 days sowing) both years and I the mean of two years.

Fresh weight was significantly affected at 60 and 90 DAS and at harvest. 2 irrigation produced significantly higher fresh weight followed by 3 irrigations than one irrigation.

The dry weight of plants and higher of main shoot at 30, 60, 90 and at harvest was significantly higher in I_2 followed by I_3 than I_1 level of irrigation. This may be due to the beneficial utilization of the amount of water available to the crop with irrigations than three irrigations where it would have been more, while in one irrigation it would have been less than the required amount of water. Sigh (1988), Sharma (1990), Ghalok et al. (1990), Katole ad Sharma (1991) have expressed similar views about number of irrigations.

Number of primary, secondary branches / plants, number and weight of capsules / plants, number and weight of seeds / capsule and weight of seeds / plants are important parameters of yield of seed and stover in linseed. These were also affected significantly due to the number of irrigations given to the linseed crop. I_2 (2 irrigations at 30 and 60 days after sowing) was found significantly superior followed by I_3 (3 irrigations at 30, 60 and 75 days after sowing) than I_1 (1 irrigation at 30 days after sowing) for producing higher value of the above parameters. This might be due to more available water through irrigation for the crop which has used water most efficiently in the favorable environment conditions available to the crop. It is further pointed out that there might have not been much fluctuation of moisture in the root zone in the range between soil saturation and permanent wilting points. Therefore, severe water stress might have not been experienced at any stage of

the development of above mentioned yield attributes. Jorder *et al.* (1979), Yusuf *et al.* (1981), Bhardwaj (1983), Prasad and Eshanhullah (1986), Sharma (1990), Shrivastava (1990), Singh *et al.* (1991) and mentioned in Annual Report of AICORPO 1994-95, due to irrigation improvement in the above yield attributes improved the yield of the crop.

Total biomass in the crop (grain+stover) q/ha, seed yield and stover yield q/ha were found significantly higher in I_2 level of irrigation followed by I_3. Both these levels produced higher yield of seed and stover/ha than I_1. This may be due to better growth and development of the yield attributes like primary branches, secondary branches, number and weight of capsules and number and weight of seeds per capsule and seed weight per plant. Thus the I_2 and I_3 irrigation levels affected all the above yield attributes with the concomitant effect on seed and stover yield of the crop. These findings were in agreement with those of Howard and Khan (1924), Smith (1946), Jorder *et al.* (1979), Bhardwaj (1983), Shrivastava (1990) and with the results of AICORPO of 194-95 and 1998-99 (AICORPO- Annual Report of 1994-95 & 1998-99). Oil content and oil yield q/ha and protein percent content in linseed were not affected significantly in both the years and in the mean of 2 years indicating that irrigation levels have not affected oil content percent, oil yield q/ha and protein percent content significantly, however, I_2 level of irrigation had more oil percent

and protein percent content in linseed. These results are not in agreement with that of Zaman and Das (1991).

Interaction effect:

The interaction effect DxV on fresh weight of plant at 90 days after sowing was found significant in both the years and in the pooled data of 2 years (Table-11(c)). At 90 days after sowing the linseed plants accumulated quiet a good amount of fresh weight. At this stage D_2V_2 (25^{th} October sowing and variety Neelum) combination produced the maximum fresh weight amongst other dates of sowing and varieties showing that Neelum variety performed better than other varieties when it was sown at 25 October due to favourable environmental factors of growth. Hence resulted maximum fresh weight of plant. As the interaction of DxV was significant at 90 days after sowing in both the years and in the pooled data, so at plant harvest stage also same trend continued and at this stage also V_2 and D_2 surpassed all other combinations showing that Neelum when sown at 25 October produced the highest fresh weight of plants.

Interaction effect of VxI (Variety x irrigation levels) was also found significant at harvest but only in the year 1998. Here also V_2 (Neelum) recorded significantly higher fresh weight of plant at harvest stage that all other combinations of VxI, sowing that Neelum did well at 2 irrigations that 1 and 3 irrigations even when

the production conditions given were similar except irrigation level due to the reasons already given above.

Interaction effect of dates of sowing and variety on dry weight of plant was also found significant in both the years and in the pulled data at 30 days after sowing. Like interaction of VxD in fresh weight of plants, the dry weight of plants at 30 days after sowing was found significantly higher value in V_2D_2 (Neelum sown at 25 October). The reason for this may be the same as given in fresh weight of plant interaction.

Interaction effect of dates of sowing and varieties on dry weight of plants at harvest stage was also significantly higher in D_2xV_2 combination (25 October sowing x Neelum variety). In both the years and in the mean of 2 years indicating that dry weight of plant was highly affected by this combination at the harvest stage too due to better utilization of all the factors of production and due to favourable weather conditions.

Interaction effect of dates and varieties were found significant in both the years and in the mean of two years on 50 percent flowering of the crop. In this interaction D_1 (10 October sowing) interacted with V_2 (Neelum) and produced significantly higher number of 50 per cent flowering indicating that due to early sowing (10 October) V_2 (Neelum) produced more 50 percent flowers than other DxV combinations under same set of production factors of the linseed crop.

Interaction effect of DxV on height of main shoot at 30 days after sowing was found significantly higher in D_1xV_2 (10 October sowing x Neelum) than other dates of sowing and varieties. In both the years and in the mean two years. This might be due to the fact that V_2 got more days in D_1 (10 October sowing) to get height than other dates of sowing and in other varieties. But incase of this interaction of DxV, at 60 days after sowing D_2xV_2 had recorded more height of main shoot due to better development of main shoot under favorable weather conditions particularly temperature and humidity in later days. The effect of interaction was found significant in both the years and in the pooled data due to these reasons.

Interaction effect of DxV on number of primary branches was found significant in both the years and in the pooled data in D_2 (25 October sowing) and V_2 (Neelum) due to better development of growth and formation of primary branches in this combination than other DxV combination for this parameter.

DxI interaction was found significant on number of primary branches in 1998-99 year only I_2 (2 irrigations) x D_2 (25 October sowing) produced the significantly higher number of primary branches than other DxI combinations. This may be due to the reasons given above in DXV interaction.

Interaction between date of sowing and varieties was also found significant and D_2xV_2 (25 October sowing and Neelum

variety) recorded the highest number of secondary branches/plant in both the years and in the pooled data. This may be due to the best availability growth factors in Neelum variety when sown at 25 October. Interaction effect of date of sowing and irrigation was found significant only in the year 1999 and D_2xI_2 (25^{th} October sowing with 2 irrigations) produced higher number of secondary branches. This may be due to favourable growth and development of secondary branches in this combination. Similarly V_2xV_1 had also recorded higher number of secondary branches only in the year 1999 due to the reasons given above in I_2 and V_2 combinations than other combinations of irrigation x variety.

Interaction effect of date and variety was also found significant in both the years and in the mean of two years on number of tertiary branches/plant. V_2xD_2 recorded the higher number of tertiary branches/plant due to reasons given above.

Interaction effect of date of sowing and variety was also found significant on number of capsules/plant in both the years and in the pooled data. Here in this interaction also V_2 (Neelum) at D_2 (25^{th} October sowing) produced the maximum number of capsules/plant due to favourable weather conditions in D_2 and due to better development of capsules/plant in the genetically good variety Neelum. Due to similar reasons interaction effect of DxV was also found significant in both the years and in the pooled data

and D_2xV_2 combination recorded higher weight of capsules/plant higher than all other combinations.

The interaction effect of DxV was also found significant in case of number of seeds/capsule in 198 only. D_2xV_2 (25^{th} October sowing x Neelum variety) recorded the higher weight of capsules than all other DxV combinations. The reasons for this interaction is also the same as mentioned above. Effect of this interaction was also found significant in case of weight of seed/capsule in the year 1999 only due to the better growth, development and accumulation of dry matter in seeds in this combination of date of sowing and variety.

Interaction of DxV on weight of capsules (mg) was also found significant in both the years and in the mean of two years. D_2xV_2 (25^{th} October sowing date x Neelum variety) combination produced significantly higher weight than all other combinations in both the years. D_1xV_2 and D_3xV_2 were next combinations with higher weight of capsules. But these combinations were at par. This indicated that V_2 (Neelum) produce almost similar weight of capsules when sown either at 10 October or 10 November each year. This may be due to the better growth, development and formation of capsules in V_2 at D_2 sowing each year. Similar views were also given in the Annual Report of AICORPO of 1998-99 from the results of trials conducted at Raipur and Kanpur.

Interaction of DxI (date of sowing and irrigation) were also found significant only in the year 1998 with D_2XI_2 combination producing significantly higher weight of capsules with 2 irrigations and by sowing on 25th October due to higher weight production of capsules in this combination, due to favourable growing and development conditions of the crop.

Interaction of effect of variety and irrigation was also found significantly in both the years and in the pooled data of two years. V_2 (Neelum variety) with I_2 (two irrigations) recorded the significantly highest weight of capsule in both the years and in the pooled data. However this variety is followed by V_4 (Laxmi-27) and I_2 irrigation level significantly with higher weight of capsules than V_1 and V_3 (Shubhra and Sweta) varieties. This indicates that under Bundelkhand condition these two varieties with two irrigations produce higher capsule weight due to favourable ecological and varietal inherent characters.

Date of sowing and varieties combinations had also affected the weight of seeds/plant. Both V_2 (Neelum) and V_4 (Laxmi-27) recorded significantly higher weight of seeds/plant in both the years and in the pooled data than other varieties but V_2 (Neelum) tops in seed weight/plant. Both V_2 and V_4 had produced higher seed weight significantly than V_1 and V_3 both in D_2 followed by D_1 dates in both the years and in the mean of two years. This might be due to better growth development and accumulation of dry matter

in these varieties than other remaining varieties, resulting in higher seed weight/plant. Genetical capabilities of these varieties at D_2 (25^{th} October sowing) coupled with favourable conditions might have produced higher seed weight in these two varieties.

Date of sowing and varietal combinations had also affected the total produce in both the years and in the pooled data. In all the DxV combinations significantly higher total produce was recorded by D_2xV_2 followed by D_2xV_4 in both the years this may be due to the reason already given above.

Variety x irrigation interaction was found affecting the total yield significantly only in the year 1998 and V_2 (Neelum) and followed by V_4 (Laxmi-27) has recorded higher total yield at I_2 (2 irrigations 30 & 60 days after sowing) due to better yield capacity of V_2 and V_4 at 2 irrigations and 1 irrigation which were significantly better than I_3 (3 irrigation). This may be due to better performance of V_2 and V_4 at I_2 and I_1 levels of irrigation.

Seed yield q/ha with dates of sowing interaction effect was found significant in both the years and in the pooled data. Though V_2 and V_4 difference in yield was also significant in both the years at D_2 and D_1 dates of sowing, but the combinations of both the varieties at D_2 and D_1 dates was found significantly better than other varieties combination with dates of sowing. This indicated that higher grain yield in these two varieties at D_2 and D_1 dates of sowing might be due to better utilization of all the factors of

production than other dates of sowing x variety combinations in both the years. Both these varieties performed better at D_2 and D_1 dates of sowing owing to their higher yield capacity than the varieties.

Higher seed yield q/ha is the better utilization of all the factor of production, especially soil fertility and irrigation facilities. These two varieties (V_2 and V_4) at I_2 and I_1 irrigation levels have significantly produced higher seed yield q/ha in the year 1998 only. V_2xI_2 and V_4xI_2 interactions resulted significantly in higher seed yield q/ha than other combinations showed these V_2 and V_4 varieties utilized maximum all the factors of production resulting higher seed yield q/ha in one year only.

Interaction effect of DxV on stover yield was also found significant in both the years and in the pooled data like the grain yield V_2xD_2 and V_4D_2 combinations produced significant higher stover yield in both the years and in the pooled data like grain yield q/ha due to the reasons mentioned in thje seed yield q/ha above.

Interaction effect of date of sowing and varieties on oil yield q/ha was also founds significant in both the years and in the pooled data. In both the years and in the mean of two years V_2 and V_4 (Neelum and Laxmi-27) with D_2 and D_1 dates of sowing combinations had recorded significantly higher yield of oil q/ha. This may be due to fact that yield of seeds q/ha was also higher in these two varieties at D_2 and D_1 irrigation levels which multiplied

with per cent oil content of V_2D_2, V_2D_1 and V_4D_2, V_4D_2 produced the maximum oil yield q/ha in these combinations of varieties and date of sowing.

Interaction effect of variety x irrigation level of oil yield quintal/hectare was found significant only in the year 1998. V_2 (Neelum) and V_4 (Laxmi-27) recorded higher yield of oil q/ha at D_2 (2 irrigations at 30 and 60 DAS) D_1 (1 irrigation 30 DAS) combinations due to higher yield seed q/ha in these combination when multiplied with percent oil yield q/ha resulted in higher oil yield q/ha.

SUMMARY AND CONCLUSION

CHAPTER-VI
SUMMARY AND CONCLUSION

An investigation entitled "Studies on the effect of different dates of sowing, varieties and number of irrigations on yield attributes, yield and quality of linseed (*Linum usitatisimum* L.) under Bundelkhand conditions of U.P." was conducted in *Rabi* season of 1998-99 and 1999-2000 at Bharmanand Post Graduate College Rath, district Hamirpur, U.P. The treatment comprised three dates of sowing (10 October, 25 October and 10 November each year), four varieties (Shubhra, Neelum, Sweta and Laxmi-27) and three levels of irrigation (1 irrigation at 30 days after sowing, 2 irrigations at 30 and 60 days after sowing and 3 irrigations at 30, 60 and 75 days after sowing), thus in all there were thirty six treatment combinations replicated three times and compared in single split plot design.

The important findings obtained from this investigation are summarized below:

Effect of dates of sowing:

1. Plant population was not affected significantly due to dates of sowing in both the years.
2. Fresh weight of plant was not affected due to sowing at 30 days after sowing. However at 60, 90 days after sowing and at harvest D_2 had recorded significantly higher fresh weight of plant, and minimum in D_3 in both the years.

3. Dry weight of plant was significantly higher in D_2 at 30, 60, 90 days after sowing and at harvest. D_1 and D_3 were at par in both the years.
4. Height of main shoot of plant was significantly minimum in D_3 and both D_1 and D_2 were at par but significantly superior than D_3 in both the years at 30 and 60 days after sowing. At 90 days after sowing D_2 had maximum height and D_3 the minimum but at harvest the difference in height of main shoot was not significant in both years.
5. Number of primary and secondary branches per plant was significantly higher in D_2 and minimum in D_3 in both the years.
6. Number of tertiary branches per plant was significantly higher in D_2 and minimum in D_3 in both the years.
7. Number and weight of capsules/plant was significantly higher in D_2 than D_3 and D_1 in both the years.
8. Number and weight of seed/capsule was significantly higher in D_2, which was at par with D_1 while minimum number ad weight of seed/capsule was in D_3 in both the years.
9. Weight of seed/plant was significantly higher in D_2 and the minimum was in D_3, while D_2 and D_1 were at par in both the years.
10. Biomass q/ha was significantly affected due to date of sowing. D_2 had significantly higher biomass weight than D_1

which had higher weight than D_3 which produced the minimum biomass q/ha in both the years.

11. Seed yield and stover yield q/ha was significantly maximum in D_2, followed by D_1 while D_3 recorded minimum both seed and stover yield q/ha in both the years.
12. Percent oil content in linseed was significantly higher in D_3 while minimum was found in D_3, which was at par with D_1 in both the years.
13. Percent protein content in linseed was significantly higher in D_2 and minimum was in D_3, while D_1 and D_3 were at par in both the years.

Effect of varieties:

1. Plant population was not affected significantly due to varieties in both the years.
2. Fresh weight of plant (g) was significantly affected due to varieties at 30, 60, 90 days after sowing. It was significantly higher in V_2 (Neelum) followed by V_3 (Sweta) and V_1 (Shubhra) and minimum was recorded in V_4 (Laxmi-27) at all the 3 stages of observations in both the years of the trial. However at harvest the order of significance was different than these stages. Significantly higher fresh weight was in V_2, followed by V_4 (Laxmi-27) and the minimum fresh weight was found in V_1 (Shubhra) in both the years.

3. Dry weight of plant (g) was found significantly higher in V_2, followed by V_3 (Sweta), V_1 (Shubhra) and the minimum dry weight of plant was found in V_4 (Laxmi-27) at 30, 60 and 90 days after sowing in both the years. However the fresh weight of plant was significantly different at harvest. At this stage significantly maximum weight was recorded in V_2 (Neelum), followed by V_4 (Laxmi-27) and V_3 (Sweta) and the minimum was found at this stage in V_1 (Shubhra) in both the years.

4. Height of main shoot (cm) 30 days after sowing was significantly higher in V_2, followed by V_3 and V_1 while it was minimum significantly in V_4 (Laxmi-27). At 60 days after sowing, the height of main shoot was significantly higher in V_2 followed by V_1 and V_3 and the minimum was in V_4 in both years. Height of main shoot at 90 days after sowing was significantly higher in V_2, followed V_3 and V_1 and the minimum was in V_4 in both years at this stage of observation. At harvest stage also the same order was observed in both the years.

5. Significantly higher number of primary and secondary branches was recorded in V_2 (Neelum), followed by V_4 (Laxmi-27) and V_3 (Sweta) while minimum number was recorded in V_1 (Shubhra) in both the years of the trial. Number of tertiary branches/plant was of the same order of

significance in both the years as was recorded in case of primary and secondary number of branches/plant.

6. Number of capsules and weight of capsules/plant was found significantly higher in V_2 variety followed by V_4 and V_3 and minimum was found in V_1 variety in both years of the trial.
7. Number and weight of seed/capsule in different varieties were affected significantly. Higher number and weight of seed was found in V_2 (Neelum) followed by V_4 (Laxmi-27) and V_3 (Sweta) while minimum number and weight of seed was in V_1 (Shubhra) in both years.
8. Weight of seed/plant was significantly higher in V_2 and V_4 followed by V_3 and minimum weight was in V_1 (Shubhra) in both the years.
9. Weight of biomass of different varieties was significantly differing in both the years. Significantly maximum weight was in V_2 (Neelum), followed by V_4 (Laxmi-27) and V_3 (Sweta). Minimum weight of biomass of V_1 (Shubhra) in both the years.
10. Weight of seed and stover q/ha was significantly affected in different varieties. Both seed and stover weight was maximum significantly in V_2, followed by V_4 and V_3 while the minimum weight was found in V_1 (Shubhra) variety in both the years.

11. Percent oil content in linseed was significantly higher in V_4 followed by V_1, V_3 and minimum in V_2 (Neelum) in both the years.

12. Percent protein content was also differing significantly in linseed varieties of the trial. It was significantly higher in V2 (Neelum) followed by V_4 (Laxmi-27), V_1 (Shubhra) while it was minimum in V_3 (Sweta) in both the years.

Effect of number of irrigations:

1. There was no significant difference in plant population of the crop due to number of irrigations applied to the crop of linseed during both the years.

2. Fresh weight of plant was significantly affected due to the number of irrigations. I_2 (irrigation at 30 and 60 days after sowing) recorded significant maximum fresh weight than I_1 and I_3 irrigation numbers (1st irrigation at 30 days, 2nd at 60 days and 3rd at 75 days after sowing). Though I_1 and I_3 are statistically at par in both the years, but I_3 had higher fresh weight than I_1. This trend was found in 20, 60, 90 days after sowing and at harvest stages of the trial.

3. In dry weight of plant observations in both years at 30, 60, 90 days after sowing and at harvest had also the above similar trend found like the values recorded in case of fresh weight of plant mentioned above.

4. Height of main shoot was significantly more in I_2 (2 irrigations at 30 and 60 days after sowing) followed by I_3 (3 irrigations at 30, 60 and 75 days after sowing) and I_1 (1 irrigation at 30 days after sowing). Both I_3 and I_1 were at par in both the years at 30 and 60 days observations after sowing. Height of main shoot 90 DAS and at harvest also affected by the irrigation which was significantly higher at I_2 (2 irrigations at 30 and 60 days after sowing) followed by I_3 (3 irrigations at 30, 60 and 75 days after sowing) and I_1 (1 irrigation at 30 days after sowing) which were at par but I_3 (3 irrigations at 30, 60 and 75 days after sowing) had recorded more height of main shoot in both the years.
5. Number of primary and secondary branches/plant were higher in I_2 (2 irrigations at 30 and 60 days after sowing) which was significantly better than I_1 (1 irrigation at 30 days after sowing). I_1 was also significantly superior than I_3 (3 irrigations at 30, 60 and 75 days after sowing) levels of irrigation in both the years.
6. Number of tertiary branches/plant of linseed crop of the trial was also significantly higher in I_2 (2 irrigations at 30 and 60 days after sowing) than other levels of irrigation of both the years, however, I_1 (1 irrigation at 30 days after sowing) was also found significantly better than I_3 (3

irrigations at 30, 60 and 75 days after sowing) levels of irrigation in both the years.

7. Number and weight of capsules/plant was found significantly superior with respect to these parameters in I_2 (2 irrigations at 30 and 60 days after sowing) than I_1 (1 irrigation at 30 days after sowing) level of irrigation, which was also better significantly than I_3 (3 irrigations at 30, 60 and 75 days after sowing) level in both the years.
8. Weight of seed/plant was significantly higher in I_2 (2 irrigations at 30 and 60 days after sowing) level of irrigation than I_1 (1 irrigation at 30 days after sowing) which was also recorded significantly higher number of seed per plant than I_3 (3 irrigations at 30, 60 and 75 days after sowing) level of irrigation in both the years.
9. Total production of biomass was significantly higher in I_2 (2 irrigations at 30 and 60 days after sowing) level than in I_1 (1 irrigation at 30 days after sowing), which was also significantly superior in total production of biomass than I_3 (3 irrigations at 30, 60 and 75 days after sowing) level of irrigation in both the years.
10. Seed yield q/ha was recorded significantly higher in I_2 (2 irrigations at 30 and 60 days after sowing) level which was at par with I_1 but higher than I_3 level of irrigation in 1^{st} year while in 2^{nd} of the trial, I_2 (2 irrigations at 30 and 60 days

after sowing) recorded significantly higher yield of seed q/ha than I_1 (1 irrigation at 30 days after sowing) level which was also significantly produced higher yield than I_3 (3 irrigations at 30, 60 and 75 days after sowing) level of irrigation.

11. Stover yield of linseed crop of the trial recorded significantly higher in I_2 (2 irrigations at 30 and 60 days after sowing) level of irrigation than I_1 (1 irrigation at 30 days after sowing) level which was significantly superior than I_3 (3 irrigations at 30, 60 and 75 days after sowing) level of irrigation in both the years.
12. Percent oil content in linseed was not affected significantly due to irrigation levels. However, in both the years I_2 (2 irrigations at 30 and 60 days after sowing) and I_3 (3 irrigations at 30, 60 and 75 days after sowing) levels of irrigation had more percent oil content than I_1 (1 irrigation at 30 days after sowing) level of irrigation. Similar results were also noticed in protein percent in seed in both the years.

Interaction effect:

1. The maximum fresh weight at 90 days after sowing was found in D_2V_2 and the minimum by D_3V_4 combination in both the years.

2. At harvest stage maximum fresh weight of plants was recorded in D_2V_2 and minimum by D_3V_4 in both the years. Interaction of VxI was maximum with respect to fresh weight of plants in V_2I_2 and minimum V_1I_3 in the year 1998 only.
3. 30 days after sowing dry weight of plant was maximum in D_2V_2 while minimum was at D_3V_4 in both the years.
4. 50 percent flowering was recorded in D_1V_2 and minimum D_3V_4 combinations in both the years.
5. D_1V_2 combinations recorded the maximum height of main shoot at 30 days after sowing and minimum was in D_3V_4 in both the years while at 60 days after sowing the maximum height of main plant was in D_2V_2 and minimum in D_3V_4 combination in both the years.
6. Maximum number of primary branches/plant was recorded by D_2V_2 and minimum in D_1V_1 combinations in both the years.
7. Interaction effect of DxI was found only in the year 1998. Maximum primary branches/plant was in D_2I_2 and minimum in D_3I_3 combination.
8. Maximum number of secondary branches/plant were recorded in D_2V_2 and minimum in D_3V_4 combinations in both the years.

9. DxI interaction recorded maximum number of secondary branches/plant in D_2I_2 while minimum in D_3I_3 combination in the year 1999 only.
10. Secondary branches/plant were maximum in V_2I_2 and minimum in V_4I_3 combination in the years 1999 only.
11. Tertiary branches/plant were found maximum in D_2V_2 and minimum in D_3V_4 combinations in both the years.
12. Number of capsules/plant were found maximum in D_2V_2 and minimum in D_3V_4 combinations while weight of capsules per plant were found maximum in D_2V_2 and minimum in D_3V_4 combinations in both the years.
13. Maximum number of seeds/capsule was found in D_2V_2 and minimum in D_3V_1 combinations in both the years.
14. Maximum number of weight of seeds/capsule was recorded in D_2V_2 and minimum in D_3V_4 combinations in the year 1999 only.
15. Weight of capsule (mg) was found maximum in D_2V_2 and minimum in D_1V_1 combinations in both the years while it was maximum in I_2D_2 and minimum in D_3I_3 combinations in the year 1998 only.
16. Interaction effect of VxI on weight of capsule was maximum in V_2I_2 and minimum in V_1I_1 combinations in both the years.

17. Weight of seeds/plant was found maximum in D_2V_2 and minimum in D_3V_1 combination in both the years.
18. Total produce q/ha was maximum in D_2V_2 and minimum was found in D_1V_1 combinations in both the year while maximum weight of total produce was found in V_2I_2 and minimum in V_1I_1 combinations in the year 1998 only.
19. Maximum seed yield q/ha was found in D_2V_2 and minimum in D_3V_1 combinations in the year while maximum seed q/ha was maximum in V_2I_2 and minimum in V_1I_1 combination in the year 1998 only.
20. Stover yield q/ha was recorded maximum in D_2V_2 and minimum in D_3V_1 combinations in both the years.
21. Oil Yield q/ha was found maximum in D_2V_2 and minimum in D_1V_1 combinations in both the years while maximum oil yield q/ha due to VxI was found in V_2I_2 and minimum V_1I_3 in the years 1998 only.

Effect of economics:

Maximum net return by sowing Neelum and Laxmi-27 (V_2 and V_4 varieties) at I_2 (2 irrigations at 30 and 60 days after sowing) between 10 October and 25 October. The maximum B:C ratio was found in treatment $D_2V_2I_2$ followed by $D_1V_2I_2$ and $D_2V_2I_1$ in first years and $D_2V_2I_2$, $D_2V_2I_1$ and $D_1V_2I_2$ in 2nd year.

CONCLUSION

From the above two year trial it is concluded that Neelum and Laxmi-27 linseed varieties be sown at 25 October and 2 irrigations (at 30 and 60 days after sowing) should be given to get maximum yield under Bundelkhand condition of Uttar Pradesh.

BIBLIOGRAPHY

BIBLIOGRAPHY

Agrawal, K.K., Tiwari, J.P. and Jani, K.K (1994). *J. Oilseed Res.* 11(1): 81-83.

Agrawal, K.K., Jain, K.K. and Sharma, R.S. (1997). *J. Oilseed Res.* 14(2): 335-337.

Anonymous (1992). 25 years research highlight of ICAR (1967-1992).

Anonymous (1995). Improved technologies in oilseed (a feedback from frontline demonstration 1995).

Aulok, M.S. and Bahal, G.S. (1989). *Indian J. of Agril. Sci.* 57(10): 673-675.

Bhardwaj, A.K. (1983). Performance of mustard under irrigation and fertilizer constraints. *M.Sc. (Ag)Thesis, G.B. Pant Agril. & Techno., Pantnagar.*

Bisnoi, K.C. and Singh, K. (1979). Effect of sowing dates and nitrogen levels on yield and yield attributes of raya & toria. *J. Agron.* 24(2): 123-129.

Chapman, H.D. and Pratt, P.P. (1961). Methods of analysis for soils, plants and water. VIII T 300 P. Published by University of California, U.S.A.

Chauhan, D.V.S. (1963), Vaigyanik Krishi. Published by Ratan Book Depo, Mathura.

C. Singh (1989). Modern technologies of Raising Field Crops. Published by Oxford & IBH Publishers, New Delhi.

Critchfield, H.J. (1966). General Climatology. Published by Prentice Hall, New Jersey, U.S.A.

Despande, R.B. and Malik, B. (1937). *Indian J. Agric. Sci.* 7: 341-348.

Despande, R.B. and Jeswani, L.M. (1954). *Indian J. Genetics.* pp. 7-13.

Dillaman, A.C. and Hopper, H. (1943). U.S.A. Deptt. of Agri. Tech. Bull. No. 844. pp. 45.

Drewtt, E.G. (1980). Linseed, winch mere Irrigation Res. Sta MAF Ashurton Newzeland Report. pp. 198.

Dubey, R.N. and Mathuria, O.P. (1984). Notification on crop standards and release of varieties of C.S. Azad Agril. & Tech. University, Kanpur.

Dubey, S.N. and Singh, T.P. (1994). *Indian J. of Agron.* 39(2): 332-334.

El-Damaty and El-Kobbia, M.T. (1958). *Annals of Agric. Sci. Faculty Agric. University, Cairo.* 3(1): 63-70. (CF Field crop Abstract 16(1): 365).

Fisher, R.A. (1925). Statistical methods for research workers. 4th Edition, Oliver & Royal Publisher, London.

Garg, D.K. (1961). Facts about Rajasthan crops. Published by Gupta and Sons, Moradabad, U.P.

Ghalok, S., Jounda Gaw Chatterjee, P. (1990). Environment and Ecology, 1990. 8(18): 383-386.

Ghosh, A.K. and Chatterjee, B. (1988). Effect of dates of sowing on oil content and fatty acid profiles of Indian mustard. *J. Oilseed Res.* 5: 144-149.

Guan, Y.E. and Zhangto (1987). Studies on major characteristics of flax. Zingzia Agril. And Forestry Science Technology. 5: 6-9.

Gupta, G.P. (1962). Synthesis of oil at various stages of development in linseed. *Indian Oilseed J.* 6(3): 207-210.

Gupta, S.C. and Godawat, S.L. (1981). *Madras Agric. J.* 68: 426-430.

Gupta, T.R. (2001). Indian Farming. Vol.21 November 2001 No. 8.

Gupta, U.S. (1987). Physiological Aspects of Dryland Farming (1987). Published by Oxford & IBH Publishers, New Delhi.

Henery, A. and Danlay, H.C. (1988). *Indian J. of Agricultural Sciences*. 58: 794-795.

Howard, G.L.C. and Khan, A.R. (1924). Deptt. of Agric. (India) Bulletin No. 2 Linseed 12: 138-183.

Jeswani, L.M. and Guglani, P.L. (1964). *Indian Oilseed J.* 9: 38-39.

Jeswani, L.M. (1984). Oilseed Production and Constraint. Published by Oxford and IBH Publishing Co. (1984).

Jibhakate, B.M. and Jaipurkar, M.A. (1991). *PKV-Research J.* 15(2): 137-139.

Johnson, I.P. (1932). *J. Agric. Res.* 45: 239.

Jorder, O.L. Paul, N.S. and Ghosh, S.K. (1979). Effect of irrigation and fertilizer on mustard. *Exptd. Agric.* 15(3): 299-302.

Katole, N.S. and Sharma, O.L. (1990). *J. of Oilseed Res.* 7(2): 22-25.

Khan, A.H., Khan, M.I. and Din, F. (1992). *J. of Agril Res., Lahore*. 30(1): 133-140.

Khan, G.M. (1980). Water use efficiency, yield and quality of raya in relation to water stress. Ph. D. Thesis, HAU, Hissar.

Khan, G.M. and Agrawal, S.K. (1985). *Haryana Agri Uni. J. Res.* XV(1): 82-83.

Koshta, L.D. and Battawar, H.B. (1981). *Indian J. Agron.* 26: 194-195.

Kumar, A. and Shastry, A.B. (1984). Crop weather and plant density parameters in relation to productivity and quality of mustard. *Ann. Agric. Res.* 5(1&2): 79-84.

Kumar, V and Prasad, S.M. (2001). *Indian J. of Agron.* 46(1) : 171 - 176. March 2001.

Lahiri, J.R. (1964). A study of effect of time of sowing on growth, yield and quality of mustard. *M.S.c (Ag.) Thesis of Agronomy of IARI, New Delhi.*

Lender, E.G. (1934). Flax production in Kansas Cir, Kansas State Agric. Expt. Station Bull. 173.

Mahapatra, A.K. (1993). *India J. Agron.* 38(3) : 496-497.

Majumdar, D.K. (1962). A study on the effect of time of sowing and fertilizer on growth, yield and quality of brown sarson. *M.Sc. (Ag) Thesis, Division of Agron., IARI, New Delhi.*

Malik, Y.P., Pandey, N.D. and Singh, S.V. (1996). *Indian J. of Entomology.* 58(2): 132-135.

Mandal, B.K. Mahapatra, S.K. and Saha, A. (1991). *Indian Agriculturist* 1991. 33(2): 73-80.

Maini, N.S., Sandhu, J.S. and Johal, K.S. (1964). *Indian Oilseed J.* 8(2):128-132.

Muhauar, R.D., Dutta, N.P., Shankar, S. and Yay Donaliare (1965). Soil testing in India Under U.S.A. International Development Mission to India. 39: 40-45.

Mullar, W. (1952). Der-Einfluss Von Lichet, temperature and subtract die ker mung von Samen einiger Angew Bot. 26: 100-110. Field crop Abst. 5(4): 228.

Nagraya, H.M. , Ramchandrappa, B.K. and Naiyappa, H.V. (1996). *Mysore J. of Agric. Sci.* 30(4) 331-336.

Ojha, R.S. (1985). Notification of variety LMH-27. Published by C.S.A. Univ. Kanpur.

Olsen, S.R., Cole, C.V. and Dean, L.A. (1956). Estimation of available phosphorus in soil. U.S. Deptt. of Agriculture Circular 939. pp. 19.

Padmini, D.R., Porwal, B.L., Jain, M.P. and Patel J.C. (1992). *Indian J. of Agron.* 37(3): 477-80.

Pandey, R.C., Singh, M., Agrawal, S.K. and Khan, R.A. (1970).*Indian J of Agronomy.* 15(2): 125-130.

Panse, V.G. and Sukhadme, P.V. (1954). Statistical methods for Agricultural Workers ICAR, New Delhi.

Payasi, S.K. Bose, U.S. and Singh, A.K. (1999). Correlation studies in linseed (*Linum usitatissimum*) *Advances in Plant Sci.* 12(1): 177-182.

Phalwan, D.K. and Kapre, M.M. (2002). Rabi special number of Krishi Vishva. 30(2): 51-52.

Piper, C.S. (1950). Soil and plant analysis. Univ. of Adelaide, Australia. pp. 223-227.

Prasad, U.K. and Eshanullah, M.D. (1986). *Indian Farming.* 36(5): August 1986.

Prasad, U.K. and Eshanullah, M.D. (1988). *Indian J. of Agron.* 33(1): 47-51.

Rajput, R.L., Sharma, M.M., Verma, O.P and Chauhan, D.V.S. (1991). Response of mustard varieties to date of sowing. *Indian J. Agron.* 36(Supp.): 153-155.

Rajput, R.L. and Gautam, D.S. and (1993). *Guj. Agril. Univ. Res. J.* 19(1): 88-89.

Rai, Bhupendra (1999). Tilhan ki kheti. Published by ICAR, New Delhi.

Ram, S.D. (1993). Annual Report of Birsa Agril. Univ. Kanke (Bihar). pp. 12.

Rana, D.S., Saran, G. and Pachuri D.K. (2000). *Annals of Agricultural Res.* 21(1): 37-41.

Rao, M. (1982). Increasing linseed productivity. *Indian Farming.* 32(8): 67-71.

Rao, M.V. (1984). Inaugural at Agril. Res. Station Durgapura on 6th August 1984.

Rao, S.K. (1980). Genetic improvement of yield in linseed. *Ph.D. Thesis J.N. Krishi Vishwa Vidyalaya, Jabalpur.*

Rathore, C. (1995). Rabi ki pramukh phaslen for Kota region. Published by Deptt. of Agriculture Rajasthan.

Raheja, R.C. (1978). ICAR information pamphlet No.88. Published by IARI, New Delhi.

Reddy, P.S. (1990). Oilseeds in India's agricultural economy. A Guide book of Fertilizer Development and Consultation Organization, New Delhi.

Richard, S.A.L. (1954) Diagnosis and improvement of saline and alkaline soil. U.S.A Deptt. Agri. Washington Hand Book No. 50.

Richharia, R.H. (1950). Wealth from waste. Published by United Press, Bhagalpur, Bihar.

Saini, J.S. (1972). Tips for increasing mustard yield. *Progressive Farming.* 9(1): 12.

Saran, G. and Giri, G. (1987). *J. of Agric. Sci., Cambridge.* 108: 560-566.

Sen, B. and Chakravarty, S.C. (1944). *Curr. Science.* 13: 234-235.

Sethi, B.L. and Sharma, J.N. (1952). Field Crops. Published by Sharma & Co., Nawabganj, Kanpur.

Sharma, K.C. (1999). Bharat ki Pramukh Phaslen. Published by GVP Agriculture University.

Singh, A.K. and Singh, B.B. (1991). *Indian J. of Crop Physiology.* 34(4):382-386.

Singh, B., Singh, B.P., Faroda, A.S. and Gupta, S.K. (1994). Effect of irrigation and N levels on teh quality and oil yield of mustard. *Indian J. Agron.* 39(2): 262-65.

Singh, G.S. and Gill, K.S. (1961). Study of seed colour in linseed in relation to quantity and quality of oil. *Indian Oilseed J.* 5: 31-33.

Singh, H.D. (1968). *Indian J. of Agronomy.* 13: 215-218.

Singh, Neelam (1978). Genetic studies in linseed. Ph.D. Thesis, *Rani Durgawati University, Jabalpur.*

Singh, R., Patidar, T. and Singh, B. (2001). *Indian J. of Agronomy.* 46(2):292-295.

Singh, S. and Singh, R.P. (1985). Effect of varying levels of nitrogen and varieties on yield and yield attributes of mustard. *Indian J. Agron.* 30(1): 79-83.

Singh, S.P., Dixit, R.S. and Singh, G.R. (1999). *J. of Oilseed Res.* 14(2):229-232.

Singh, S.S. (1988). Principles and practices of Agronomy. Published by Kalyani Publisher, Ludhiana.

Singh, Subedar, Singh, N.P. and Singh, N. (1991) *Annals of Agric. Res.* 12(1):32-37.

Singh, Y. (1991). *Indian J. of Agronomy.* 36(3): 429-430.

Smith, E.G. (1949). The linseed crop. *Newzeland J. Agric.* 73: 459-63.

Srivastava, S.R. (1990) Krishi Vishwa. 3: 15-16.

Suman, R.C. and Rai, B. (1990). Environment and Ecology. 8(14) 251-252.

Tandon, J.N. and Chauhan, D.V.S. (1995). Bharat ki Pramukh Phaslen. Published by Ram Prasad & Sons, Agra.

Thosar, V.R., Ulemale, R.B. and Jibhkate, B.M. (1990). *Annals of Plant Physiology*. 4(1): 54-58.

Tiwari, K.P., Dixit, J.P. and Saran, R.N. (1988). Effect of nitrogen and irrigation on some linseed cultivars. *Indian J. of Agron.* 33(1): 44-46.

Tomar, G.S., Sharma, R.S. and Kurmi, N. (1985). *J. of Oilseed Res.* 2: 210-217.

Tomar, R.K.S. and Mishra, A.K. (1992). *Krishi Annusandhan Patrika*. 7(2): 136-140.

Tomar, S.S. (1998). Studies on varietal response to advance sowing in mustard. *Ph.D. Thesis, Dr. B.R. Ambedkar University, Agra.*

Vivek, K. Chakar, I.S. and Sharma, H.K. (1998). *Indian J. of Agronomy*. 39(1): 142-143.

Yadav, K.S. and Yadav, M.S. (1997). *Indian J. of Agronomy*. 42(1): 159-161.

Yarmanos, D.M. and Worka, G.F. (1964). Cyclic production of capsules in flax. California Agricultural Bulletin.

Yusuf, M., Sadaphal, M.N. and Singh, N.P. (1981). Growth yield and oil content in safflower as influenced by water supply. *Indian J. of Agron.* 2(4): 423-427.

Zaman, A. and Das, P.K. (1991). *Indian J. of Agronomy*. 36(2): 177-179.

Maiti, P.K. and Chttopadhyaya, S. (1988). Indian Agric 24(1) : 43-47

Rai, B.K., and Kuniar, A (1978) Indian farming 28(4) : 14-17.

Rai S.B. (1980)- effect of varying level of fertilizes and date of sowi on yield of linseed Varieties Ph. D Thesis submitted to B.H. Vanarasi.

Rai, M, (1982) increasing linseed production Indian Farming 32:4 & 5.

Subbiah, B.V. and A Sijha G.L. (1956), current science vol 251 : 1 - 260).

Maiti, P.K. and Chttopadhyaya, S. (1988). Indian Agric 24(1) : 43-47

Rai, B.K., and Kuniar, A (1978) Indian farming 28(4) : 14-17.

Rai S.B. (1980)- effect of varying level of fertilizes and date of sowing on yield of linseed Varieties Ph. D Thesis submitted to B.H.U. Vanarasi.

Rai, M, (1982) increasing linseed production Indian Farming 32:4 & 5.

Subbiah, B.V. and A.-Sijha G.L. (1956), current science vol 251 : (259 – 260).

APPENDIX

Appendix-1: Value of Mean Sum of Squares of plant population/plot.

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	11.2936	13.2097	24.4283
Dates of sowing (S)	2	52.9531	3.2902	24.7384
Error (a)	4(8)	24.2064	20.7936	22.5000
Varieties (V)	3	10.9565	19.9814	13.8158
DxV	6	0.3257	10.8673	3.7627
Irrigation levels (I)	2	9.1714	6.5128	2.6436
DxI	4	1.5986	1.8709	3.4588
VxI	6	0.9358	1.3254	2.2274
DxVxI	12	0.3754	1.8796	1.6800
Error (b)	66(132)	77.1147	13.6107	45.3627

Figure given in parentheses ~~are~~ represent pooled error degree of freedom

Appendix-2: Value of Mean Sum of Squares of fresh weight of plant at 30 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	8.31604*	0.873211	5.3894*
Dates of sowing (S)	2	0.655673	2.060144	2.3544
Error (a)	4(8)	0.681615	0.709881	0.69574
Varieties (V)	3	10.20603**	7.034981**	16.91225**
DxV	6	0.967981	1.005706	1.9733
Irrigation levels (I)	2	0.385848	2.171469	2.1834
DxI	4	0.029102	0.072126	0.09155
VxI	6	0.025711	0.059020	0.07788
DxVxI	12	0.159799	0.122410	0.2797
Error (b)	66(132)	1.466675	0.618344	1.042509

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-3: Value of Mean Sum of Squares of fresh weight of plant at 60 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	1.304381	1.258725	2.5623
Dates of sowing (S)	2	25.416151**	21.405033*	47.1624**
Error (a)	4(8)	1.248286	1.706450	1.477368
Varieties (V)	3	41.267038**	39.979067**	80.1266**
DxV	6	2.161510	1.717900	3.85395
Irrigation levels (I)	2	15.179026**	13.421658**	26.5632**
DxI	4	0.723047	0.829396	1.5484
VxI	6	2.169907	0.562425	2.2086
DxVxI	12	0.585017	0.454346	1.03071
Error (b)	66(132)	1.884072	2.414590	2.149331

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-3: Value of Mean Sum of Squares of fresh weight of plant at 60 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	1.304381	1.258725	2.5623
Dates of sowing (S)	2	25.416151**	21.405033*	47.1624**
Error (a)	4(8)	1.248286	1.706450	1.477368
Varieties (V)	3	41.267038**	39.979067**	80.1266**
DxV	6	2.161510	1.717900	3.85395
Irrigation levels (I)	2	15.179026**	13.421658**	26.5632**
DxI	4	0.723047	0.829396	1.5484
VxI	6	2.169907	0.562425	2.2086
DxVxI	12	0.585017	0.454346	1.03071
Error (b)	66(132)	1.884072	2.414590	2.149331

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-4: Value of Mean Sum of Squares of fresh weight of plant at 90 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	9.394269	21.202284	28.2183
Dates of sowing (S)	2	235.618858**	257.920223**	492.929**
Error (a)	4(8)	1.714969	2.314658	2.0148135
Varieties (V)	3	576.767685**	544.25093**	1122.8301**
DxV	6	8.539724**	14.73436**	21.5563**
Irrigation levels (I)	2	112.061853**	100.522715**	211.5386**
DxI	4	1.144015	0.865309	1.98987
VxI	6	0.927081	1.292933	2.1896
DxVxI	12	0.889266	1.200622	2.0657
Error (b)	66(132)	2.528081	2.880996	2.70453

Figure given in parentheses [redacted] represent pooled error degree of freedom[redacted]

** = Significant at p = 0.01

Appendix-5: Value of Mean Sum of Squares of fresh weight of plant at harvest

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	33.450673	14.507636	44.0581
Dates of sowing (S)	2	2778.73262**	2957.55995**	6415.8456**
Error (a)	4(8)	20.467152	21.063124	20.76514
Varieties (V)	3	4078.03105**	4403.14252**	8476.4137**
DxV	6	109.862542**	48.67953**	146.2591**
Irrigation levels (I)	2	669.947959**	896.40736**	1558.3776**
DxI	4	8.553893	10.532344	18.9834
VxI	6	45.540695**	1.193745	14.7461
DxVxI	12	11.051767	6.769574	17.2992
Error (b)	66(132)	12.735843	15.356674	14.0463

Figure given in parentheses are represent pooled error degree of freedoms

** = Significant at p = 0.01

Appendix-6: Value of Mean Sum of Squares of dry weight of plant at 30 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	0.002826	1.641779	0.1355
Dates of sowing (S)	2	0.414626**	0.422729*	0.8424**
Error (a)	4(8)	0.090826	0.050226	0.070526
Varieties (V)	3	0.050956**	0.054087**	0.1044**
DxV	6	0.004193**	0.005702**	0.00977**
Irrigation levels (I)	2	0.027268**	0.031823**	0.0308**
DxI	4	0.000347	0.000829	0.001073
VxI	6	0.000223	0.000613	0.000739
DxVxI	12	0.000463	0.000673	0.001115
Error (b)	66(132)	0.001032	0.001056	0.001044

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-7: Value of Mean Sum of Squares of dry weight of plant at 60 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	0.495005	1.004851	1.4071*
Dates of sowing (S)	2	4.987334**	3.779359**	8.8254**
Error (a)	4(8)	0.179698	0.189713	0.1847055
Varieties (V)	3	3.294263**	2.649512**	5.77215**
DxV	6	0.059671	0.271537	0.25441
Irrigation levels (I)	2	2.328484*	2.630418**	4.9848**
DxI	4	0.019763	0.054401	0.06558
VxI	6	0.058044	0.073640	0.13071
DxVxI	12	0.035239	0.077823	0.10469
Error (b)	66(132)	0.492716	0.466902	0.479809

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-8: Value of Mean Sum of Squares of dry weight of plant at 90 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	0.352808	0.420512	0.94183
Dates of sowing (S)	2	58.747225*	52.537937*	111.5016**
Error (a)	4(8)	5.297467	7.037262	6.16736
Varieties (V)	3	43.455742**	37.070641**	80.17347**
DxV	6	1.136958	1.627507	2.72052
Irrigation levels (I)	2	7.390975*	13.844562**	20.9034**
DxI	4	0.12515	0.732095	0.60522
VxI	6	0.079775	0.332010	0.32548
DxVxI	12	0.101717	0.196194	0.28239
Error (b)	66(132)	1.926468	1.083200	1.504834

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-9: Value of Mean Sum of Squares of dry weight of plant at harvest

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	8.865615	27.193503	31.04213
Dates of sowing (S)	2	3064.22389**	3865.9350**	6881.4024**
Error (a)	4(8)	14.784663	13.39066	14.08766
Varieties (V)	3	4477.045815**	4890.6944**	9359.4254**
DxV	6	60.768804**	43.8125*	98.20754**
Irrigation levels (I)	2	892.635718**	710.24591**	1597.7976**
DxI	4	11.320045	5.00567	15.04659
VxI	6	4.743018	20.862677	19.8946
DxVxI	12	7.129673	16.593895	21.75395
Error (b)	66(132)	10.826796	14.695183	12.760988

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-10: Value of Mean Sum of Squares of days to 50% maturity.

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	1.8611	40.0648	17.2702
Dates of sowing (S)	2	949.0833**	1068.1759**	2013.7407**
Error (a)	4(8)	15.5694	12.9120	14.2407
Varieties (V)	3	2684.5278**	2506.8642**	5188.351**
DxV	6	10.5278	6.8179	16.9443
Irrigation levels (I)	2	1056.333**	1078.9537**	2135.1298**
DxI	4	6.4583	8.5093	14.8270
VxI	6	6.7778	19.7809	23.1573
DxVxI	12	1.9028	2.3179	4.18999
Error (b)	66(132)	18.6667	15.5084	17.0876

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

** = Significant at p = 0.01

Appendix-11: Value of Mean Sum of Squares of days to 50% flowering.

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	11.1204	61.0278	52.0977
Dates of sowing (S)	2	1617.8981**	1494.25**	3109.6907**
Error (a)	4(8)	4.8704	23.7778	14.32409
Varieties (V)	3	1615.5648**	1621.5556**	3237.1094**
DxV	6	42.3426**	49.8056**	91.8455**
Irrigation levels (I)	2	1093.4815**	1173.25**	2265.3274**
DxI	4	1.7731	3.5000	4.9779
VxI	6	6.8148	7.4722	14.2719
DxVxI	12	5.5509	3.7222	9.09010
Error (b)	66(132)	6.5295	9.4672	7.99835

Figure given in parentheses are represent pooled error degree of freedoms

** = Significant at p = 0.01

Appendix-12: Value of Mean Sum of Squares of height of main shoot at 30 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	1.398269	7.020548	6.2571
Dates of sowing (S)	2	65.890069**	99.682726**	163.6056**
Error (a)	4(8)	1.719839	1.577233	1.648536
Varieties (V)	3	12.380699**	26.534071**	37.4726**
DxV	6	7.760457*	9.134228**	16.1343**
Irrigation levels (I)	2	20.537569**	5.928751**	22.6268**
DxI	4	0.236701	0.508291	0.6925
VxI	6	0.461313	0.278813	0.7170
DxVxI	12	0.314933	0.110388	0.3722
Error (b)	66(132)	2.852112	1.025639	1.9389

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-13: Value of Mean Sum of Squares of height of main shoot at 60 DAS.

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	21.409668	0.411325	5.85286
Dates of sowing (S)	2	126.01225*	90.968353*	215.8779**
Error (a)	4(8)	11.701158	11.873253	11.787205
Varieties (V)	3	237.851401**	216.373425**	447.1758**
DxV	6	48.618212*	32.68994**	79.73265**
Irrigation levels (I)	2	53.306137**	39.332953*	74.6857**
DxI	4	5.326406	0.661714	3.7497
VxI	6	6.615406	1.010207	5.1696
DxVxI	12	4.917516	0.665487	3.6167
Error (b)	66(132)	12.001593	8.627180	10.3144

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-14: Value of Mean Sum of Squares of height of main shoot at 90 DAS

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	10.221158	0.643436	5.1269
Dates of sowing (S)	2	125.748169**	130.860058*	254.2632**
Error (a)	4(8)	9.380894	9.068586	9.22474
Varieties (V)	3	514.56463**	553.68353**	1064.319**
DxV	6	7.967279	9.997647	17.84956
Irrigation levels (I)	2	102.936211**	78.755908**	174.4008**
DxI	4	3.144576	0.266371	1.8291
VxI	6	4.049754	0.724231	3.4246
DxVxI	12	3.869777	0.649860	3.1720
Error (b)	66(132)	9.688155	10.493566	10.0909

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-15: Value of Mean Sum of Squares of height of main shoot at harvest

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	209.934219	101.4325	291.8229*
Dates of sowing (S)	2	107.955811	132.1285	239.2276
Error (a)	4(8)	59.146197	52.1956	55.6709
Varieties (V)	3	569.343608**	584.9205**	1152.959**
DxV	6	11.960159	9.13056	20.9005
Irrigation levels (I)	2	106.97970**	73.1533**	172.1112**
DxI	4	2.565549	1.93595	4.45715
VxI	6	1.347767	0.93256	2.24268
DxVxI	12	1.930708	1.98365	3.90977
Error (b)	66(132)	12.157172	10.9125	11.5348

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-16: Value of Mean Sum of Squares of number of primary branches/plant

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	0.137536	0.097604	0.23172
Dates of sowing (S)	2	37.680433**	24.623695**	61.5048**
Error (a)	4(8)	0.162411	0.251901	0.207155
Varieties (V)	3	17.278218**	18.16718**	35.0773**
DxV	6	1.854499**	1.710965**	3.56257**
Irrigation levels (I)	2	21.047158**	15.432268**	36.122**
DxI	4	0.403117*	0.107165	0.415564
VxI	6	0.162576	0.316970	0.45400
DxVxI	12	0.303823	0.152138	0.42997
Error (b)	66(132)	0.147833	0.278855	0.213344

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-17: **Value of Mean Sum of Squares of number of secondary branches/plant**

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	1.028818	3.435678*	3.7601**
Dates of sowing (S)	2	400.14054**	318.11826**	714.5514**
Error (a)	4(8)	0.263573	0.3258643	0.311108
Varieties (V)	3	292.27704**	271.18241**	563.1025**
DxV	6	9.06680**	9.145839**	18.21247**
Irrigation levels (I)	2	161.780281**	146.94581**	307.9968**
DxI	4	0.148004	5.009189**	1.72203
VxI	6	0.352953	3.587458**	2.25061
DxVxI	12	1.288701	0.204028	1.025465
Error (b)	66(132)	2.712206	1.007025	1.859615

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-18: Value of Mean Sum of Squares of number of tertiary branches/plant

Source of variations	d.f.	1^{st} Year (1999)	2^{nd} Year (2000)	Pooled
Replication	2	47.712336*	21.53305	64.10427**
Dates of sowing (S)	2	1381.855519**	1408.80343**	2789.8872**
Error (a)	4(8)	3.631885	5.404008	4.5179465
Varieties (V)	3	1493.572062**	1389.59678**	2884.7344**
DxV	6	35.582685**	26.336169**	61.2244**
Irrigation levels (I)	2	600.147478**	487.877603**	1085.5608**
DxI	4	1.551139	0.318545	1.40524
VxI	6	5.953443	5.219753	11.1490
DxVxI	12	2.978708	4.872097	7.60897
Error (b)	66(132)	7.467806	6.521653	6.99473

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-19: Value of Mean Sum of Squares of number of capsules/plant

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	49.7344	26.89821	73.15097
Dates of sowing (S)	2	7511.6908**	7760.8985**	15256.873**
Error (a)	4(8)	17.5414	16.59602	17.068715
Varieties (V)	3	6235.6830**	6107.64983**	12341.1213**
DxV	6	251.8272**	178.78605**	424.3734**
Irrigation levels (I)	2	3888.2638**	3478.8703**	7272.0882**
DxI	4	10.154614	12.721487	22.7316
VxI	6	12.4848	14.14091	26.5742
DxVxI	12	16.5209	10.72653	25.6277
Error (b)	66(132)	13.68897	15.140201	14.414585

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

** = Significant at p = 0.01

Appendix-19: Value of Mean Sum of Squares of number of capsules/plant

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	49.7344	26.89821	73.15097
Dates of sowing (S)	2	7511.6908**	7760.8985**	15256.873**
Error (a)	4(8)	17.5414	16.59602	17.068715
Varieties (V)	3	6235.6830**	6107.64983**	12341.1213**
DxV	6	251.8272**	178.78605**	424.3734**
Irrigation levels (I)	2	3888.2638**	3478.8703**	7272.0882**
DxI	4	10.154614	12.721487	22.7316
VxI	6	12.4848	14.14091	26.5742
DxVxI	12	16.5209	10.72653	25.6277
Error (b)	66(132)	13.68897	15.140201	14.414585

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

** = Significant at p = 0.01

Appendix-20: Value of Mean Sum of Squares of weight of capsules/plant

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	17.217751	41.63514**	53.5466**
Dates of sowing (S)	2	424.75907**	389.065937**	814.1406**
Error (a)	4(8)	3.202069	3.703781	3.45293
Varieties (V)	3	606.40368**	609.351878**	1209.9731**
DxV	6	14.052364**	15.39922**	29.42068**
Irrigation levels (I)	2	256.30127**	270.832712**	533.2803**
DxI	4	1.264455	1.562437	2.78596
VxI	6	0.44212	3.452319	2.47004
DxVxI	12	0.960053	1.282672	2.21703
Error (b)	66(132)	2.293039	2.657034	2.4750365

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

** = Significant at p = 0.01

Appendix-21: Value of Mean Sum of Squares of number of seeds/capsule

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	0.055851	22.670336	2.2504*
Dates of sowing (S)	2	10.278956**	6.324858*	16.1448**
Error (a)	4(8)	0.32863	0.411290	0.36996
Varieties (V)	3	16.840904**	9.546000**	25.9934**
DxV	6	1.973364*	0.125625	0.9724
Irrigation levels (I)	2	13.605048**	12.196258**	25.3536**
DxI	4	0.138190	0.046158	0.15946
VxI	6	1.043856	0.205225	0.91214
DxVxI	12	0.209666	0.144475	0.34753
Error (b)	66(132)	0.609659	0.574475	0.59207

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-22: Value of Mean Sum of Squares of weight of seeds/capsule

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	22.638168	48.00325	65.9280*
Dates of sowing (S)	2	102.083612*	94.232608**	196.2162**
Error (a)	4(8)	6.290272	8.317369	7.3038
Varieties (V)	3	19.644875**	18.171567**	35.73405**
DxV	6	0.476531	5.527308**	3.24398
Irrigation levels (I)	2	6.704295*	9.486808**	15.4158**
DxI	4	0.379287	0.509971	0.87921
VxI	6	0.369503	0.431008	0.79759
DxVxI	12	0.226050	0.365188	0.57442
Error (b)	66(132)	1.895955	1.320288	1.60812

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-23: **Value of Mean Sum of Squares of weight of capsule**

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	13.54837	68.962408	61.1143
Dates of sowing (S)	2	4793.783212**	5150.580769**	9921.8168**
Error (a)	4(8)	66.87505	61.248661	64.06185
Varieties (V)	3	11107.45603**	10721.286128**	21822.166**
DxV	6	650.129018**	705.644450**	1354.6364**
Irrigation levels (I)	2	4453.28984**	4383.773436**	8866.8116**
DxI	4	77.784879*	8.39974	51.1222
VxI	6	113.430477**	63.974661*	170.3723**
DxVxI	12	5.28365	8.586192	13.4709
Error (b)	66(132)	26.605601	21.124707	23.865153

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-24: Value of Mean Sum of Squares of weight of seeds/plant

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	29.162418	34.624786	63.550*
Dates of sowing (S)	2	377.364984**	351.067433**	726.2232**
Error (a)	4(8)	7.190886	6.309094	6.749965
Varieties (V)	3	412.469841**	391.139475**	805.358**
DxV	6	7.367055**	5.301700*	12.4992**
Irrigation levels (I)	2	231.45930**	208.446308**	439.1448**
DxI	4	0.827405	0.783333	1.60946
VxI	6	0.455319	0.704808	1.12872
DxVxI	12	0.574053	1.518533	1.86690
Error (b)	66(132)	1.824778	1.579813	1.70229

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-25: Value of Mean Sum of Squares of total produce

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	72.125179*	40.285390	107.7997**
Dates of sowing (S)	2	1114.818495**	1115.699381**	2228.6706**
Error (a)	4(8)	9.009970	10.350736	9.680355
Varieties (V)	3	2261.369964**	2001.242011**	4254.3474**
DxV	6	44.691458**	69.473178**	111.4405**
Irrigation levels (I)	2	1017.952612**	819.424623**	1830.9726**
DxI	4	5.588766	7.739069	13.15309
VxI	6	43.672531**	2.285308	19.97858
DxVxI	12	4.597046	3.100771	7.55096
Error (b)	66(132)	10.629610	10.752893	10.69125

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-26: Value of Mean Sum of Squares of seed yield (q/ha)

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	3.480556	20.4276**	16.8625**
Dates of sowing (S)	2	131.201351**	113.694626**	243.6552**
Error (a)	4(8)	1.354102	1.487659	1.42088
Varieties (V)	3	204.811056**	162.568549**	365.1141**
DxV	6	3.686206**	4.30186**	7.96136**
Irrigation levels (I)	2	115.941026**	79.246226**	220.0074**
DxI	4	0.342009	0.590938	0.90047
VxI	6	5.443315**	0.103116	1.47553
DxVxI	12	0.556724	0.367706	0.904873
Error (b)	66(132)	1.080106	0.766786	0.923443

Figure given in parentheses ~~are~~ represent pooled error degree of freedom~~s~~

** = Significant at $p = 0.01$

Appendix-27: Value of Mean Sum of Squares of stover yield (q/ha)

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	3.923426	11.759979	13.5792
Dates of sowing (S)	2	583.64998**	518.111340**	1101.3576**
Error (a)	4(8)	12.721161	14.961358	13.84126
Varieties (V)	3	938.24743**	1033.937349**	1968.8926**
DxV	6	44.66977**	42.193099**	86.7268**
Irrigation levels (I)	2	360.9552**	392.347006**	752.705**
DxI	4	4.823427	6.746048	11.4085
VxI	6	4.700422	7.24301	11.667
DxVxI	12	5.103333	2.585369	7.25479
Error (b)	66(132)	4.077561	6.097204	5.5738

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

** = Significant at p = 0.01

Appendix-28: Value of Mean Sum of Squares of oil percent

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	0.745534	1.053258	1.7723
Dates of sowing (S)	2	47.129968*	34.117703**	80.5434**
Error (a)	4(8)	3.171687	1.848778	2.510232
Varieties (V)	3	37.887913**	34.079394**	71.7629**
DxV	6	2.495779	2.434073	4.92939
Irrigation levels (I)	2	7.997268	3.0276	10.4707
DxI	4	0.636418	0.954085	1.55844
VxI	6	0.220013	0.374755	0.57446
DxVxI	12	0.505563	0.405622	0.90561
Error (b)	66(132)	4.713436	4.604295	4.658865

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-29: Value of Mean Sum of Squares of oil yield (q/ha)

Source of variations	d.f.	1st Year (1998)	2nd Year (1999)	Pooled
Replication	2	0.5900	3.8329**	3.0074*
Dates of sowing (S)	2	32.7928**	26.6929**	59.6328**
Error (a)	4(8)	0.4257	0.3771	0.4014
Varieties (V)	3	32.0329**	26.0355**	57.7517**
DxV	6	0.7718*	0.8366**	1.6071**
Irrigation levels (I)	2	24.0769**	16.5208**	39.8816**
DxI	4	0.0884	0.1082	0.1952
VxI	6	1.0684**	0.0616	0.5132
DxVxI	12	0.1130	0.1073	0.2202
Error (b)	66(132)	0.3032	0.1806	0.2419

Figure given in parentheses ~~are~~ represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01

Appendix-30: Value of Mean Sum of Squares of protein content

Source of variations	d.f.	1st Year (1999)	2nd Year (2000)	Pooled
Replication	2	16.30827**	10.219525*	25.8089**
Dates of sowing (S)	2	13.639468*	13.410833**	26.8152**
Error (a)	4(8)	0.772405	1.385712	1.07906
Varieties (V)	3	85.945579**	88.084444**	180.1717**
DxV	6	1.005579	1.018611	2.02415
Irrigation levels (I)	2	2.654468	3.063333	5.6481
DxI	4	0.034884	0.058333	0.09021
VxI	6	0.013356	0.014444	0.027778
DxVxI	12	0.021273	0.0311111	0.051447
Error (b)	66(132)	2.522238	3.134217	2.8282275

Figure given in parentheses are represent pooled error degree of freedoms

* = Significant at p = 0.05

** = Significant at p = 0.01